U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-295 181

Areawide Waste Treatment Management Plan for the Greater Houston Area (Section 208, PL 92-500) Environmental Assessment

Houston-Galveston Area Council, TX

Prepared for

Environmental Protection Agency, Washington, DC

17 Apr 78

BIBLIOGRAPHIC DATA SHEET

1. Report No.

2.

3. Recipient's Accession No. PB295181

4. Title and Subtitle
IMPACT ASSESSMENT - March 1978, Revised April 17, 1978

5. Report Date March 1978
Revised, April 17, 1978

6.

7. Author(s) James Veltman & Assoc., Inc. with Camp Dresser & McKee for Houston-Galveston Area Council

8. Performing Organization Rept. No.

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10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
Houston-Galveston Area Council
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13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstracts

The purpose of this report is to provide an environmental assessment of the 208 Waste Treatment Management Plan conducted by the Houston-Galveston Area Council. The designated planning area covered by the Greater Houston Area 208 Plan includes all of Harris County and portions of Brazoria, Fort Bend, Galveston, Montgomery and Waller Counties. This report assesses the impacts of implementing the Greater Houston Area 208 Plan, and also the impacts of not implementing the 208 Plan.

17. Key Words and Document Analysis. 17a. Descriptors

Environmental Impact Assessment

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement
Unlimited distribution

19. Security Class (This Report)
X UNCLASSIFIED

20. Security Class (This Page)
UNCLASSIFIED

21. No. of Pages
288

22. Price
PC A13/MF A01

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

PB 295181

IMPACT ASSESSMENT

MARCH 1978

REVISED
APRIL 17, 1978

HGAC HOUSTON-GALVESTON AREA COUNCIL

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

THE PREPARATION OF THIS REPORT
WAS FINANCED THROUGH A GRANT FROM THE
U. S. ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL
ASSESSMENT

AREAWIDE WASTE TREATMENT MANAGEMENT PLAN
FOR THE
GREATER HOUSTON AREA
(SECTION 208, PL 92-500)

FEBRUARY, 1978

PREPARED FOR THE HOUSTON-GALVESTON AREA COUNCIL
BY
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IN ASSOCIATION WITH
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TABLE OF CONTENTS

Page

CHAPTER I -Introduction and Summary. I-1

CHAPTER II -Description of the Existing Environment and its Probable Future without Implementation of a Water Quality Management Plan

II-A Land Use. II-A-1
II-B Demographic Characteristics II-B-1
II-C Economics II-C-1
II-D Present Water Quality Conditions. . II-D-1
II-E Air II-E-1
II-F Public Health II-F-1
II-G Biology II-G-1
II-H Aesthetics. II-H-1
II-I Archeology. II-I-1

CHAPTER III -Description of Plan Alternatives and Recommendation III-1

CHAPTER IV -Description of the Recommended Plan . . . IV-1

CHAPTER V -Environmental Impacts of the Proposed Implementation of the Waste Treatment Management Plan

V-A Introduction. V-A-1
V-B Land Use V-B-1
V-C Economics. V-C-1
V-D Water Quality Impact of Selected Plan V-D-1
V-E Air. V-E-1
V-F Public Health. V-F-1
V-G Biology. V-G-1
V-H Aesthetics V-H-1

CHAPTER VI -Mitigating Measures

VI-A Introduction. VI-A-1
VI-B Land Use. VI-B-1
VI-C Economics VI-C-1

CHAPTER VI - Mitigating Measures

VI-D Water Quality. VI-D-1
VI-E Air. VI-E-1
VI-F Public Health. VI-F-1
VI-G Biology. VI-G-1

CHAPTER VII - Assessment Methodology VII-1

APPENDIX A - Land Use A-1

APPENDIX B - Comments B-1

TABLE OF ILLUSTRATIONS

Page

Tables

II-C-1 Baseline Municipal Treatment Costs. II-C-5
II-C-2 Current and Projected Industrial Discharge. . . II-C-9
II-C-3 Harris County Employment Forecast II-C-16
II-D-1 Two-Year Seven Day Low Flows at Headwaters. . . II-D-2
II-D-2 Statistical Analysis of HGAC Data Base for Segment 1008. . . . . II-D-4
II-D-3 Statistical Analysis of HGAC Data Base for Segment 1009. . . . . II-D-5
II-D-4 Statistical Analysis of HGAC Data Base for Segment 1002. . . . . II-D-6
II-D-5 Statistical Analysis of HGAC Data Base for Segment 2425. . . . . II-D-8
II-D-6 Statistical Analysis of HGAC Data Base for Segment 1101. . . . . II-D-9
II-D-7 Statistical Analysis of HGAC Data Base for Segment 1102. . . . . II-D-10
II-D-8 Statistical Analysis of HGAC Data Base for Segment 1103. . . . . II-D-11
II-D-9 Statistical Analysis of HGAC Data Base for Segment 1007. . . . . II-D-13
II-D-10 Statistical Analysis of HGAC Data Base for Segment 1006. . . . . II-D-14
II-D-11 Statistical Analysis of HGAC Data Base for Segment 1005. . . . . II-D-15
II-D-12 Statistical Analysis of HGAC Data Base for Segment 2426. . . . . II-D-16

Page

Tables (Continued)

II-D-13 Statistical Analysis of HGAC Data Base for Segment 2427. . . . . II-D-17

II-D-14 Statistical Analysis of HGAC Data Base for Segment 2428. . . . . II-D-18

II-D-15 Statistical Analysis of HGAC Data Base for Segment 2429. . . . . II-D-19

II-D-16 Statistical Analysis of HGAC Data Base for Segment 2430. . . . . II-D-21

II-D-17 Statistical Analysis of HGAC Data Base for Segment 1001. . . . . II-D-22

II-E-1 Extreme-Mile Winds. II-E-4

II-E-2 Rainfall Totals for Various Recurrance Intervals. . . II-E-4

II-E-3 Federal Ambient Air Quality Standards II-E-8

II-E-4 Primary Pollutants. II-E-10

II-E-5 Other Gaseous Pollutants. II-E-15

II-E-6 Data from Non-Continuous High Volume Sampling Stations. II-E-16

II-E-7 1973 Emissions by Subbasin. II-E-20

II-F-1 Criterion for Selected Potentially Harmful Substance II-F-2

II-G-1 Quality Criteria for Water Established by the Environmental Protection Agency II-G-9

II-G-2 Proposed EPA Qualtiy Standards for inplace Sediments II-G-17

II-G-3 Natural Areas - Legend for Figure II-G-2. . . . . . . II-G-20

II-G-4 Federally Protected, Endangered Animals which may occur in 208 Study Area II-G-28

II-G-5 Rare and Endangered Plants which may be found in 208 Study Area II-G-29

Page

Tables (Continued)

V-C-1 Cost Impacts of Proposed 208 Plan. V-C-3
VII-1 Magnitude of Environmental Impact Units. VII-5
VII-2 Matrix Chart-Primary. VII-10
VII-3 Matrix Chart-Secondary. VII-11
APPENDIX Land Use Projections - Total Change A-3
APPENDIX Employment Estimates and Projections. A-11
APPENDIX Transportation Population Estimates and Projections. A-17

Figures

II-A-1 Single Family Map. II-A-4
II-A-2 Multi-Family Map II-A-9
II-A-3 Commercial Map II-A-13
II-A-4 Industrial Map II-A-15
II-A-5 Agriculture Map. II-A-18
II-A-6 Open Space Map II-A-20
II-A-7 Undeveloped Land Map II-A-21
II-B-1 Employment Map II-B-9
II-B-2 Population Map II-B-16
II-E-1 Second Highest 24-Hour Averages of Sulfur Dioxide (1976)(In Micrograms per Cubic Meter). . . II-E-12
II-E-2 Annual Averages of Nitrogen Dioxide (1976) (In Micrograms per Cubic Meter). II-E-13
II-E-3 Annual Geometric Mean Particulate Concentrations (1976) (In Micrograms per Cubic Meter) II-E-18
II-G-1 Potential Vegetation of the HGAC Study Area. . . . II-G-3
II-G-2 Natural Areas II-G-22
II-I-1 Zones of Archeological Sites. II-I-2

CHAPTER I
INTRODUCTION

This document has been prepared in accordance with the October 18, 1977, agreement between James Veltman and Associates, Inc. and the Houston-Galveston Area Council. Specifically, the task was to provide an independent environmental assessment of the 208 Waste Treatment Management Plan being conducted by the Houston-Galveston Area Council. The Federal Water Pollution Control Act Amendments of 1972 (FWPCA) set forth requirements for controlling all types of water pollution. The overall objective of the act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101a). To achieve this objective "it is the national goal to provide for the protection and propagation of fish, shellfish, and wildlife and provide for recreation in and on the water be achieved by July 1, 1983" (Section 101 (a)2). To enable meeting the Act's objective, "it is the national policy that areawide waste treatment management planning processes be developed and implemented to assure adequate control of sources of pollutants in each state" (Section 101 (a)5). Section 208 of the act provides for encouraging and facilitating the development and implementation of areawide waste treatment management plans. Paragraph "f" of Section 208 gives the Environmental Protection Agency (EPA) the authority to make grants to designated areas for payment of developing and operating a continuing areawide waste treatment management planning process.

The National Environmental Policy Act of 1969 (NEPA) requires all Federal agencies to "utilizes systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment...." In addition, Section 102 (2)(C) of NEPA requires the agency to prepare an environmental impact statement (EIS) on "...major Federal actions significantly affecting the quality of the human environment....." One of the major EPA programs involving actions which are candidates for EIS's is the construction grant program authorized by Title II - Grants for Construction of Treatment Works, Section 201 (g)(1) of the FWPCA.

Section 208(a) (2) of the FWPCA directs the governor of each state to identify each area within the state which, as a result of urban-industrial concentrations or other factors, has substantial water quality control problems. By Executive Order No. D.B. 18 and its amendment D.B. 18-A, the Governor of Texas, Dolph Briscoe, designated the Texas Water Quality Board (TWQB) to determine eligible areas, develop guidelines and criteria, review and monitor area plans, and recommend waste treatment management agencies. These guidelines were presented in June 1975 by the TWQB. The state guidelines do not supersede the provision of the FWPCA or applicable Federal regulations; rather, they function as a supplemental document.

In December 1968, the Governor of Texas established 21 State Planning Regions in conjunction with a national movement toward innovative patterns in governmental structure. Based mainly upon common geographic and socio-economic characteristics, natural resources, agriculture, manufacturing, and a common relationship to a metropolitan focal point, these regions serve as a framework for the coordination of functional planning of state agencies and national organizations. The Gulf Coast State Planning Region is one of the five planning regions of the Texas Coastal Area. The H-GAC is a voluntary association of local political entities conforming to the boundries established by the planning region, in order to pursue common opportunities and seek common solutions to problems which may be shared by more than one local government. In addition, the Council promotes economy and efficiency among political jurisdictions within the region.

Purpose

First, the overall purpose of the H-GAC Waste Treatment Management Plan is stated as:

> "THE OVERALL GOAL OF THE GREATER HOUSTON AREA 208 PROGRAM IS TO ELIMINATE THE DISCHARGE OF POLLUTANTS INTO THE WATER RESOURCES OF THE AREA BY 1985, WITH PARTICULAR ATTENTION TO:
>
> A. Preserving and protecting the quality of groundwater resources.
> B. Preventing further degradation of bodies of water.
> C. Assuring that efforts to improve water quality take into account special problems posed by the existing uses of various bodies of water.
> D. Attaining and maintaining water quality commensurate with the protection, propagation, and human consumption of finfish, shellfish, and wildlife native to the area.
> E. Attaining and maintaining water quality that allows for recreation in and on the water.
> F. Attaining and maintaining drinkable water in as many bodies of surface water as technically, economically, and naturally possible."

The purpose of this report is to assess in a general manner the environmental impact of the program to date. It should be remembered that an environmental assessment is not an environmental impact statement but an assessment to determine if an environmental impact statement is required. This report also attempts to define in general the major areas of the 208 planning effort to date. The second chapter defines the existing environment and attempts to identify the implications of the 208 planning effort without the 208 Water Quality Management Plan.

Chapter three is a brief and condensed version of the plan alternatives investigated in the development of the "Alternative Technical Subplans" report. Chapter four is the basic elements of the recommended 208 plan and is from the summary report.

Chapter five concerns itself with the impacts of the recommended plan on a subject basis--from land use to air, biology, and archeology. Chapter six attempts to define which steps can be taken to minimize any adverse impacts of the plan. Chapter seven is the assessment methodology.

Summary

Land Use and Demographic Characteristics

Land use, although a product of population and employment growth, is the implementation of an urbanizing region and is the originator of point and nonpoint source pollution. In order to define the patterns of growth within the 208 planning area, and in order to not show absolute site specific growth, areas of significant change were used. These areas are defined as acres change and percentage growth, with acres change being the locator of growth and percentage also indicated for reference.

The majority of growth occurs in the Houston Ship Channel and Tributaries, with Lake Houston Subbasin and Clear Lake Subbasin but with all basins showing significant growth around the fringe of existing urbanization. The pattern that is predominant is a "C" pattern beginning in the Johnson Space Center Area and proceeding to the Alief area, then north to Addicks and Barker Reservoirs, then northeast along FM 1960 to Interstate 45 and Highway 59 and Lake Houston, with North Baytown also an area of high growth rates.

The major impact without the 208 planning process is in the area of nonpoint source pollution but relatively little explicit data exists, nor are the models sufficient to predict the potential impact with or without the 208 planning process. Even so..."the total pollutional load to receiving streams by urban storm runoff is still staggering".

This impact, which is backed up by strong concerns for data in the recommended plan. needs to be verified and amplified in future ongoing planning activities. Current data are insufficient for the area but are becoming more prevelant with time.

The impact with the plan, although similar to without the plan, is twofold. First, the preferred plan deals comprehensively with the point source pollution problem and addresses the issues of point source impacts. Where required, any anticipated adverse impacts to water quality are resolved by the recommendations thus creating minimal adverse impacts in specific segments but similar to the existing condition.

Secondly, the nonpoint source impact is at best, speculative, based upon inferred data from other urban areas. The preferred plan recognizes this fact and recommends the necessary data collection activities required. Assuming that similar urban areas are indicators of potential non-point source impact, the secondary impacts from growth will be significant but are recognized by the plan and will be addressed when sufficient data does become available in future continued planning efforts.

Biology

The recommended 208 Plan will produce only minor impacts on the biological resources of the 208 area. Impacts specifically identified will result only from the failure of this plan to maintain or create fishable/swimmable conditions in area streams. Further impact assessment is restricted because of the non-site specific nature of 208 studies.

The diversity of biological resources in the 208 area is a direct result of the mixture of coastal estuaries, prairies, and upland pine-hardwood forests. Historically, these habitats supported organisms which are currently absent or exist only in small, marginally reproducing populations. Several of the organisms are protected under Federal or State Statutes. Habitats of these organisms and areas which possess significant ecological value have been identified in this report. These areas and the populations of organisms inhabiting them should receive special consideration in future 208 planning.

Air

The ambient air quality in the Houston-Galveston area is generally poor, especially in the vicinity of the Houston Ship Channel. In 1976, the Air Quality Control Region containing Harris the Texas Water Quality Board (TWQB) to determine eligible areas, develop guidelines and criteria, review and monitor area plans, and recommend waste treatment management agencies. These guidelines were presented in June 1975 by the TWQB. The state guidelines do not supersede the provision of the FWPCA or applicable Federal regulations; rather, they function as a supplemental document.

In December 1968, the Governor of Texas established 21 State Planning Regions in conjunction with a national movement toward innovative patterns in governmental structure. Based mainly upon common geographic and socio-economic characteristics, natural resources, agriculture, manufacturing, and a common relationship to a metropolitan focal point, these regions serve as a framework for the coordination of functional planning of state agencies and national organizations. The Gulf Coast State Planning Region is one of the five planning regions of the Texas Coastal Area. The H-GAC is a voluntary association of local political entities conforming to the boundries established by the planning region, in order to pursue common opportunities and seek common solutions to problems which may be shared by more than one local government. In addition, the Council promotes economy and efficiency among political jurisdictions within the region.

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> F. Attaining and maintaining drinkable water in as many bodies of surface water as technically, economically, and naturally possible."

The purpose of this report is to assess in a general manner the environmental impact of the program to date. It should be remembered

County did not comply with federal ambient air quality regulations for concentrations of photochemical oxidants and non-methane hydrocarbons; also, the Houston Ship Channel does not comply with federal particulate standards. Therefore, any major developments in the vicinity of the Houston Ship Channel will come under new "offset" regulations regarding particulate emissions. Otherwise, the Houston-Galveston region is classified as a Class II area with respect to the prevention of significant deterioration.

The Environmental Protection Agency (EPA) has cited the Houston area as having some of the highest levels of air pollution in the nation. The EPA is continuing to observe the air quality in Houston closely.

WATER

The environmental assessment of the recommended 208 plan as it affects water is a key issue. With respect to the evaluation of environmental impacts, Section 208 of the Federal Water Pollution Control Act Amendments (P.L. 92-500, 1972) creates a goal of fishable/swimmable water quality by 1983. This goal is used as the yardstick to measure the water quality effect of the proposed plan. The achievement of the mandated fishable/swimmable condition is the "norm" from which the recommended plan is measured. If in a specific stream segment the plan will not lead to a fishable/swimmable condition by 1983, the goal or "norm" is not attained and the effect is evaluated as negative. If a water quality condition in a particular segment is achieved by 1983 that is better than the fishable/swimmable criteria, the effect is evaluated as positive. Meeting the goal, the "norm", is evaluated as neither a positive nor a negative environmental impact.

In all cases, water quality models were used to evaluate the changes in water quality conditions that would occur as a result of the plan recommendations. However, some of these water quality models are uncalibrated and unverified. This means that the results of the modeling studies cannot be used with a high level of confidence to predict the changes that may actually occur when the recommendations are enacted.

Areas where the fishable/swimmable conditions will be met with presently permitted discharges are:

1001 San Jacinto River

1002 Lake Houston. The water quality in Lake Houston is projected to meet fishable/swimmable water quality, however, severe eutrophication problems may occur under the presently forecasted phosphorus loadings. A eutrohpication study encompassing the entire Lake Houston watershed is recommended.

1005 Morgans Point to San Jacinto River

1008 Spring Creek

1101 Clear Creek (Tidal)

2425 Clear Lake. The effect of the preferred plan on Clear Lake will be to maintain fishable/swimmable water quality. However, a severe eutrophication condition in the lake will continue to exist while further study suggested by the preferred plan address the problem.

2426 Tabbs Bay

2427 San Jacinto Bay

2 28 Black Duck Bay

2429 Scott Bay

2430 Burnett Bay

The segments which will not meet the fishable/swimmable criteria as a result of the recommended 208 plan are:

1009 Cypress Creek. Dissolved oxygen levels in Cypress Creek are projected to fall below a fishable/swimmable water quality goal, and according to water quality modeling studies, a 2/3 reduction in benthic oxygen demand would be required to achieve acceptable DO standards. The preferred technical subplan for this segment calls for further studies to quantify benthic oxygen demands. No alternative is presented if the study determines that the benthic demand cannot be reduced enough to meet the fishable/swimmable standards. A maximum limit on instream chlorine residual is recommended. The model did not allow for the increased BOD decay rate associated with a decrease in chlorine residual. Present water quality will continue to exist until the studies are completed.

1102 Clear Creek (Nontidal). The dissolved oxygen in Clear Creek (nontidal) is projected to fall below a fishable/swimmable water quality goal. During wet weather, excess levels of fecal coliform are expected to occur.

(Unclassified) Armand Bayou. The water quality in Armand Bayou will remain below fishable/swimmable levels until further modeling efforts suggested by the plan can predict what steps should be undertaken to meet the desired water quality goals.

1103 Dickinson Bayou (Tidal). The Dickinson Bayou (tidal) segment is predicted to not meet a fishable/swimmable dissolved oxygen goal, and further modeling efforts are recommended to justify upgrading municipal waste treatment plants.

1107 Turning Basin and 1006 Turning Basin to San Jacinto River. The dissolved oxygen concentrations in the Houston Ship Channel segments 1007 and 1006 will not meet fishable/swimmable goals under present and future point source loadings. Furthermore, the modeling effort indicates that fishable/swimmable water quality is not obtainable during wet weather.

(Unclassified) Buffalo Bayou. Until such time as water quality criteria are determined the level of water quality in the bayou will remain below a fishable/swimmable level.

Mitigating Measures

Where future impacts will be found, the means for counteracting these impacts is required. The specifics will be developed in future data collection and studies. Certain measures have been identified and suggested even where data is insufficient because trends are evident in the area of non-point pollution. Several of these measures could be initiated at the present time i.e. sediment control from construction activities. In this case the problem is evident but the solution of imlementation will be long and hard in the Greater Houston region.

Public Health

The result of implementing the preferred plan with respect to public health in the Greater Houston planning area as it relates to water borne diseases will be to maintain a safe fishable/swimmable level of fecal coliform bacteria. However, only fecal coliform and dissolved oxygen have been addressed in the preferred technical subplan analyses, and the possibility exists that other potentially harmful substances may exist in the waters of the planning area. It is suggested, therefore, that further study be carried out to determine if any such substances do exist in the waters of the planning area, and if so, steps must be taken to alleviate their potential problems.

Achievement of Citizens Goals and Objectives

The Citizens Advisory Group for the Greater Houston Area 208 program, developed a series of goals and objectives as one of the means by which to evaluate the alternative technical and management plans prior to the selection of the preferred plan. These goals are stated in the Goals and Objectives report prepared by the Citizens Advisory Group for the Greater Houston Area.

Generally speaking, the procedure of the 208 planning process and efforts to date does incorporate the goals and objectives where feasible. It must be remembered that the plan is a management process that will lead to eventual implementation. The plan also identifies areas of concern, potential impacts and future data requirements. In several areas the mere identification of the problem is the first step in achievement of the goal or objective. Several goals and objectives are very encompassing and require lengthy time frames to achieve, whereas several other objectives require more data, detail, and study to realize attainment. But, the purpose of utilizing these goals and objectives for alternative technical and management plan selections, has been effected.

In the goals and objectives statement, certain areas of particular emphasis warrent special mention.

1. The recommendation creating the Water Quality Council would oversee the continuation of these goals and objectives in future decisions.
2. There has been a conscious attempt during the planning activities towards a watershed management approach and because the watersheds are distinct and require diversified recommendations, this objective has been met by utilization of the watershed as a planning unit.
3. Watershed management in the plan is still a future possibility. The current plan responds to growth and at the present time cannot limit the amount of new development. The plan does not attempt to direct growth but responds to the identification of unique areas which are check lists for future site specific planning activities. However, this conflicts with the objective of directed growth.
4. Financial incentives on a present worth basis were definitely considered in the plan selection as is illustrated by the joint treatment facilities recommended in the Lake Houston Subbasin.
5. The development of a nonpoint source pollution abatement program requires more data and studies but was recognized as a major potential problem requiring immediate attention.
6. The active public education and information program has been active throughout the entire planning process as a major activity. The use of the League of Women Voters for information dissemination, the establishment of depositories for information sources, and the activities of the CAG have all been a portion of this goal.

It must also be stated that some of the objectives can be interpreted as conflicting objectives, for example:

- providing waste treatment facilities at the time development occurs
- limiting the pollutant discharges to the capacity of available waste treatment facilities

But this does not invalidate the effort nor the applicability of the goals and objectives. The emphasis should be on flexibility and progress, relative to available data and planning processes. The liason with the technical community, the ever increasing data on environmental consequences of decisions and the continued citizen involvement in the ongoing program will resolve these conflicts in time.

CHAPTER II-A
LAND USE

Introduction

The basis for all of the 208 plans, loadings and projected flows begins with the population projections which relate to employment and land use. The physical implementation of these projections is the land use and the actual "footprints" that do occur on the land. From these "footprints" occur the point and nonpoint source pollution. As Houston grows, the urbanization progresses around the existing periphery of the city and the amount of impervious cover increases significantly causing increased runoff coefficients, increased peak flows, increased nonpoint runoff.

The patterns of growth in a general form occur as a ring to the shape of a "C" with the largest percentile growth occuring to the west and north and with the largest absolute growth (acres) currently happening to the west and southwest with future projected growth occuring to the north and northwest.

The source of this information is the Houston-Galveston Area Council document "Population Land Use for the Greater Houston 208 Area" and is the accepted given for the 208 plan. This point should be stressed strongly. The basic data in the plan is 1974 data complied in 1975 and are interim numbers. One of the major items required in the future activities of the 208 planning process is the update of population, demographic, and land use projections.

It should also be stressed that the 208 planning effort in the Greater Houston area is a function of land use and not the impetus that causes land use growth. Houston's growth is caused by many factors, but the mere fact of it's growth is what causes the need for the 208 planning process, especially in the area of nonpoint source pollution. Lnad use and impervious cover are inseparable. Increasing population requires increased urbanization and this produces increased urban runoff and waste treatment. The analysis of this phenomena is the 208 planning process.

In this chapter, the following definitions apply for land uses designated:

- --Single-Family Residential including duplexes.
- --Multiple-Family Residential including apartments, boarding houses, mobile home parks, condominiums.
- --Commercial and Services including retail and wholesale trade, personal services, business activities and offices, hospitals and medical facilities, communication and amusement facilities.
- --Industrial including light and heavy manufacturing, port and terminal facilities, utility plants and substations, waste water treatment facilities and solid waste disposal sites, mineral extraction activities, refineries, airports (only the physical facilities on the airport porperty are designated), warehousing.
- --Parks and Open Space including areas generally reserved from urban development such as city and county parks and recreational facilities, golf courses, cemeteries, zoos, wildlife refuges, protected floodways, easements, greenbelts.
- --Agricultural including lands used for crops, pastures, orchards, groves, vineyards, feedlots.
- --Vacant Land including areas not in current use which may be available for development, primarily within urban areas, but not being used for agricultural or other purposes.
- --In census tracts outside Harris County the vacant and agricultural categories are totaled and reported as undeveloped.

Introduction to Land Use by Planning Unit

In the tabulations of land use and in an attempt to indicate the proper areas of significant change, land use was tabulated in terms of percentage growth and absolute acres of growth. The identification of the land use growth area is by acres increased with the percentage growth also indicated for reference.

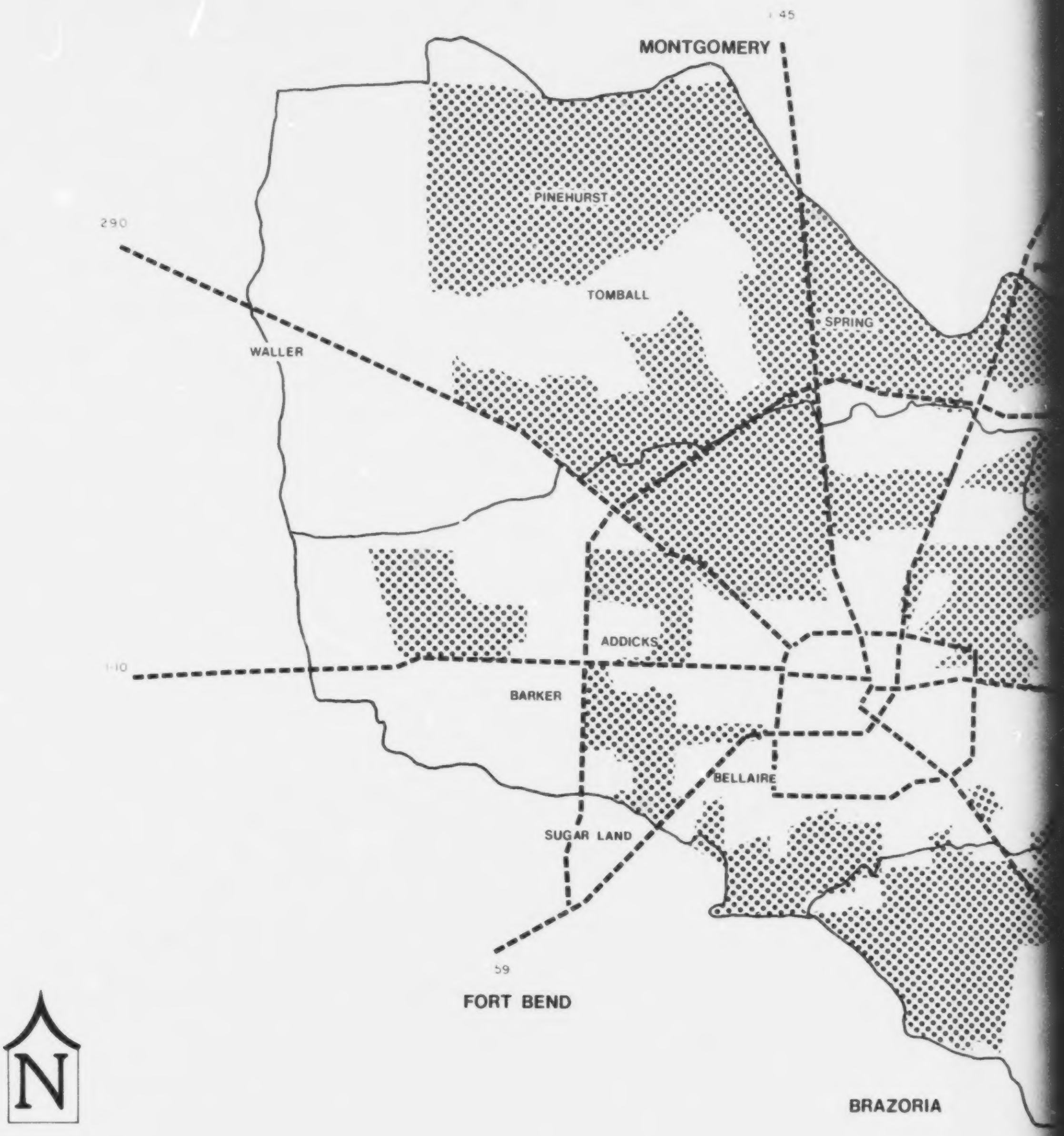
Single Family Growth For Total Planning Period 1975-1995

Houston Ship Channel and Tributaries

Single Family - Areas of significant growth 1975-1995, 300 acres of more.

Beginning with the heart of this watershed is the central core of the City of Hosuton. In single family land use in the central core, the majority of the census tracts show a decrease in acreage from 0-300 acres, but show increase in multi-family and commercial thus increasing the nonpoint source runoff and land coverage of impermeable surfaces. The areas through the watershed that are considered to be areas of significant growth are those census tracts of 300 or more acres growth and are defined as follows with the first number being the census tract, second is the percent growth and third being the acres increased.

Census Tract	%	Acres	Census Tract	%	Acres	Location
339	107	517.0	332	95	549.5	South of Loop 610 @ the Astrodome to Harris County Line along Hwy 288 then west to Stafford.
340	85	455.6	334	75	559.3	
338	71	318.4	701	54	1252.7	
336	181	430.5	433	51	313.0	
436	67	969.3	438	85	1263.4	Alief area, north of Stafford and east of Baker Resevoir South of I-10.
423	35	401.0				
447	34	404.7	542	90	507.4	North of I-10, east and north of Addicks Reservoir, south of Hwy 290.
452	39	300.2				East of Katy, north of I-10.
541	48	428.7	540	106	946.0	The near northwest, between Hwy 290 and I-45 from North Houston to FM 1960 a solid and contiguous area with North Houston and FM 1960 area having the highest percentile growth.
529	302	942.3	525	78	808.2	
530	30	718.6	531	35	634.0	
539	29	350.5	534	123	382.1	
Portions of						
545	29	642.9	538	59	966.2	
551	67	531.1	537	64	409.2	
536	77	713.5				
533	12	322.8	241	74	386.7	Houston Intercontintal Airport to Aldine between I-45 and Hwy 59.
240	44	858.3				
247	996	797.3				West of Lake Houston east of Humble, south of FM 1960.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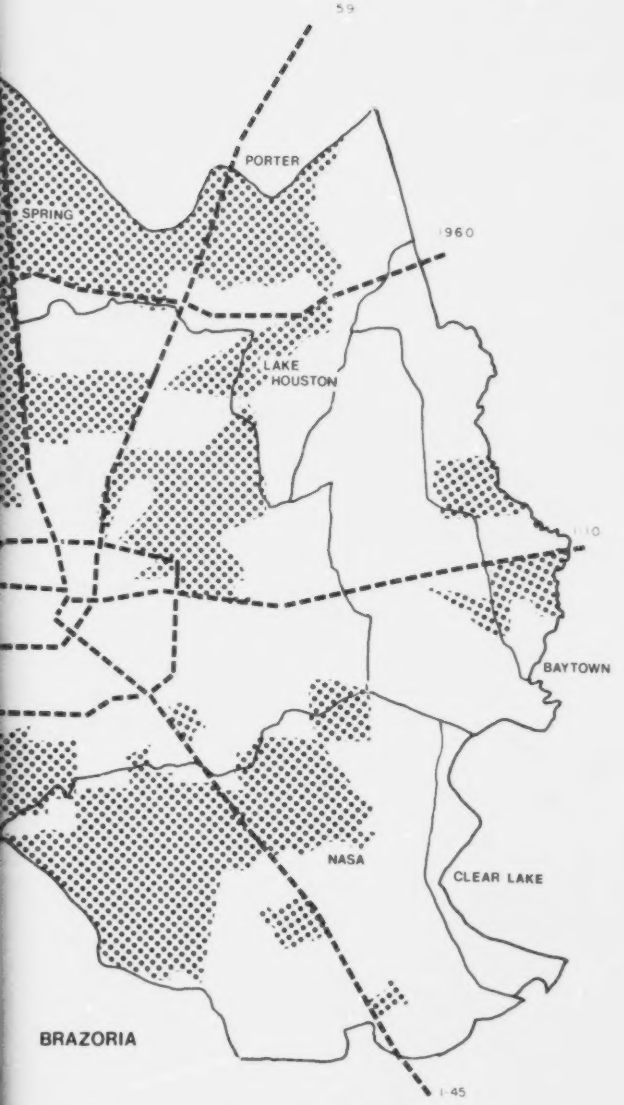
Environmental Assessment

SINGLE FAMILY

TOTAL ACREAGE CHANGE

▨ 300 & ABOVE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Management Plan

HGAC GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

DRAWN BY: JAMES VELTMAN & ASSOCIATES inc. DATE: 2-78	REVISIONS BY: DATE:	EXHIBIT II-A-1 SCALE SECTION

Census Tract	%	Acres	Census Tract	%	Acres	Location
224	27	391.7	227	58	384.8	Near northeast, outside Loop 610, Intersection of Halls and Greens Bayou and vincinity.
216	66	376.1	226	94	631.1	
215	32	493.3	236	60	458.5	
214	212	1033.0	213	99	822.2	
323	62	314.3	342	401	646.3	East and west of Hobby Airport.
344	214	487.7				
257	267	347.4				East of Cedar Bayou north of I-10.
261	89	648.0	267	83	393.3	North Baytown.

Lake Houston Subbasin

Single Family - Areas of significant growth 1975-1995, 300 acres or more.

The pattern that is predominant occurs on both sides of Cypress Creek from Highway 290 to Highway 59, all of Southern Montgomery County to the area south of Porter, west of Lake Houston and F.M. 1960 north side, with the eastside of I-45 having the highest percentage growth. More specifically, these areas are described as follows:

Census Tract	%	Acres	Census Tract	%	Acres	Location
545	29	642.9	558	68	617.2	Cypress Creek, both sides along FM 1960. North side from Hwy 290 past I-45 to hwy 59.
551	67	531.1	559	84	698.5	
555	53	306.3	244	192	711.0	
and portions of						
538	59	966.2	537	64	409.2	
536	77	713.5				
903	37	803.5	901	41	1058.5	All of southern Montgomery Co. from Pinehurst to Porter.
902	94	1605.3	249	125	790.1	
247	996	797.3(partial)				Northwest of Lake Houston.

Clear Lake Subbasin

Single Family - Areas of significant growth 1975-1995, 300 acres or more.

The predominant pattern occurs in the northern portions of the watershed from the northside of Johnson Space Center west into Northern Galveston County with Harris County having the highest percentage growth. The areas are described as follows:

Census Tract	%	Acres	Census Tract	%	Acres	Location
370 359	195	477.0	360	35	365.7	Northern Armand Bayou watershed, Deer Park Pasadena and J.S.C. Area.
375	175	393.3				West of Webster.
371	58	776.8	601	39	385.3	South of Hobby Airport into Galveston County.
345	156	684.5	602	73	1121.2	

Multifamily Growth
Total Growth 1975-1995

Note: Because of the density of multifamily developments, areas of 100 acres or more are considered significant.

Houston Ship Channel and Tributaries

Multi-Family - Areas of significant growth 1975-1995, 100 acres or more.

The general pattern based upon acreage change is the south and western portions of the basin, with scattered tracts to the north and east and a major number of tracts within the 610 Loop indicating growth of 100 acres or more.

Census Tract	%	Acres	Census Tract	%	Acres	Location
203	800	113.3	329	3701	203.6	Astrodome and Loop 610 to Fort Bend.
317	242	231.6	339	389	120.2	
331	500	260.0	338	253	115.2	
414	106	131.7	332	404	101.0	

Census Tract	%	Acres	Census Tract	%	Acres	Location
415	180	124.5	333	1206	165.2	
334	270	163.6	336	191	211.0	
335	411	104.9	432	231	139.4	
701	172	200.6				
407	85	136.2	402	697	258.0	SW Freeway from Loop 610 to Montrose.
508	733	101.1				East of I-45 inside Loop 610
405	116	103.1				Greenway Plaza Hwy 59
309	425	220.2	313	227	104.5	I-45 south inside Loop 610
314	307	107.2				
218	153	105				Hwy 59 north of Loop 610.
307	201	151				Hwy 288 at Brays Bayou.
422	74	222.1	445	89	109.4	The general area between Hwy 59 and I-10 from Loop 610 to Hwy 6, Barker Resevoir and south to Alief and north of Hwy 59.
423	73	288.9	446	66	185.0	
424	145	279.7	438	534	942.5	
425	102	123.0	437	380	341.8	
419	78	438.1	436	329	323.1	
517	92	189.7				
447	244	445.2	528	14820	148.2	Addicks Resevoir East and northeast between Hwy 290 and I-10.
444	52	157.6				
529	329	564.6	530	990	194.1	North Houston area off Hwy 290 and east.
525	1648	341.3	442	93	106.6	
538	613	107.4 partial				FM 1960 between Steubner-Airline and Hwy 149.

Census Tract	%	Acres	Census Tract	%	Acres	Location
533	214	321.8				South of Northbelt (Greenspoint Mall) and East of I-45.
226	155	100.9				Intersection of Greens and Halls Bayou.
213	223	271.2	230	390	175.4	I-10, east of Loop 610. Jacinto City City to Channelview.
232	549	151.1				
324	89	137.6	345	186	144.4	Hobby Airport.
268	368	129.0	266	266	100.0	East of Baytown.

Lake Houston Subbasin

Multi-Family - Areas of significant growth 1975-1995, 100 acres or more.

This watershed only indicates two areas of significant multi-family growth which are:

Census Tract	%	Acres	Census Tract	%	Acres	Location
902	835	259.8				Southern Montgomery County at I-45 (The Woodlands area)
538	613	107.4				FM 1960 between Steubner-Airline and FM 149.

Clear Lake Subbasin

Multi-Family - Areas of significant growth 1975-1995, 100 acres or more.

The upper portions of the Clear Lake SubBasin indicate the greatest increases in multi-family growth, both Upper Armand Bayou watershed and Clear Creek account for the areas of significant increases.

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TOMBALL
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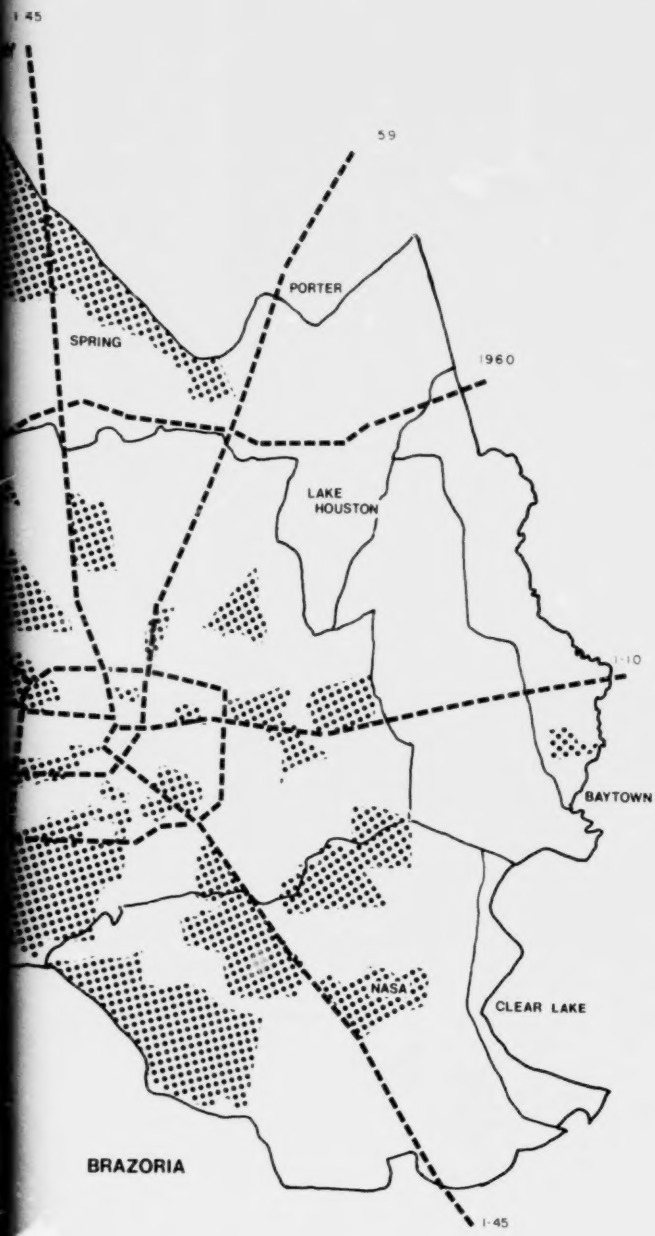
BRAZORIA

Areawide Waste Treatment Managem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BAYTOWN
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BRAZORIA
I-45

Environmental Assessment

MULTI-FAMILY

TOTAL ACREAGE CHANGE

▨ 100 & ABOVE

anagement Plan

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

DRAWN BY: JAMES VELTMAN & ASSOCIATES inc. DATE: 2-78	REVISIONS BY: DATE:	EXHIBIT II-A-2 SCALE SECTION

Census Tract	%	Acres	Census Tract	%	Acres	Location
359	209	219.5	360	104	121.9	Deer Park and Pasadena area.
358	144	143.6				
373	164	172.3				Johnson Space Center.
346	442	114.8	371	544	302.2	Southeast of Hobby Airport along I-45.
602	264	124.2				Northern Brazoria County.

Commercial Growth
Total Growth 1975-1995

As one would expect, the pattern for commercial growth follows closely the patterns of single family and multi-family land uses. As with multi-family the intensity of land use in commercial is very high relative to impermeable cover and is thus considered significant if 100 acres or more are projected in future years.

Houston Ship Channel and Tributaries

Commercial - Areas of significant growth 1975-1995, 100 acres or more.

The majority of the commercial growth is suburban growth. Very little occurs inside Loop 610. The pattern is strong along FM 1960 with a clustering occuring between Katy and the resevoirs, Interstate 10 east of Loop 610, Highway 59 in the vicinity of Humble and south of the Astrodome. A noticable decrease occurs within the City of Bellaire and vicinity along the Downtown and Galena Park areas.

Census Tract	%	Acres	Census Tract	%	Acres	Location
343	76	134.9				West of Hobby Airport.
338	352	128.6	332	284	212.5	Astrodome and Loop 610 south along Hwy 288.
339	193	190.5	331	37	221.4	
334	156	302.4				
423	17	103.3				SW Freeway (59), just west of Loop 610.
419	18	134.1				

Census Tract	%	Acres	Census Tract	%	Acres	Location
436	144	334.1	438	111	503.8	South and east of Barker Resevoir.
428	111	503.8				
447	73	154.6				East and north of Addicks Resevoir east of FM 1960.
542	88	127.7				
449	193	207.1	452	261	156.6	Interstate 10, north and southside from Katy to the resevoirs.
450	561	168.2				
451	1236	123.6				
540	1100	192.5				Northwest Freeway from North Houston to FM 1960.
541	201	321.8				
529	171	299.6				
545p	93	167.8				
538p	141	286.7				FM 1960, southside, from FM 149 to the RR tracts east of I-45, from FM 1960 to Halls Bayou on the south.
539	86	125.6				
537p	188	192.8				
534	320	152.4				
533	54	176.4				
535p	221	226.5				
402	184	112.4				Montrose area.
243	128	115.4				Intercontinental Airport south and east to Hwy 59 in the vicinity of Humble.
241	169	135.6				
245	41	106.1 partial				
224	42	123.0				Intersection of Greens and Halls Bayou.
226	126	180.0				
214	711	224.1				Interstate 10 and 610 Loop east and north of I-10 from Jacinto City to the San Jacinto River.
213	108	143.0				
228	84	109.8				
229	189	104.0				
230	42	121.0				
262	698	122.2				North Baytown, south of I-10.
261	476	131.1				
322	130	136.3				Sims Bayou at 225 south of the Ship Channel.

Lake Houston and Tributaries

Commercial - Areas of significant growth 1975-1995 100 acres or more,

Generally, the pattern is concentrated along FM 1960 from Hwy 290 to Hwy 59 and into Montgomery County along I-45.

Census Tract	%	Acres	Census Tract	%	Acres	Location
545	93	167.8				Cypress Creek along 290.
555	1336	701.4				FM 1960 from HWY 149
556	239	155.5				to east of I-45 and
558	318	231.2				into southern Montgomery
538	141	286.7	partial			County along I-45.
537	188	192.8	partial			
536	111	241.9	partial			
559	298	231.0				
902	59	104.6				
245	41	106.1	partial			1960 and 59, Humble.

Clear Lake SubBasin

Commercial - Areas of significant growth 1975-1995, 100 acres or more.

The concentration is centered around Ellington Airforce Base and Johnson Space Center and is basically one cluster in the upper Armand Bayou subshed and Clear Creek basin.

Census Tract	%	Acres	Census Tract	%	Acres
346	62	143.5	370	287	265.5
345	42	123.9	373	34	111.2
371	285	491.8	366	107	213.9
347	94	169.0			
359	74	113.0			

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Areawide Waste Treatment Manage

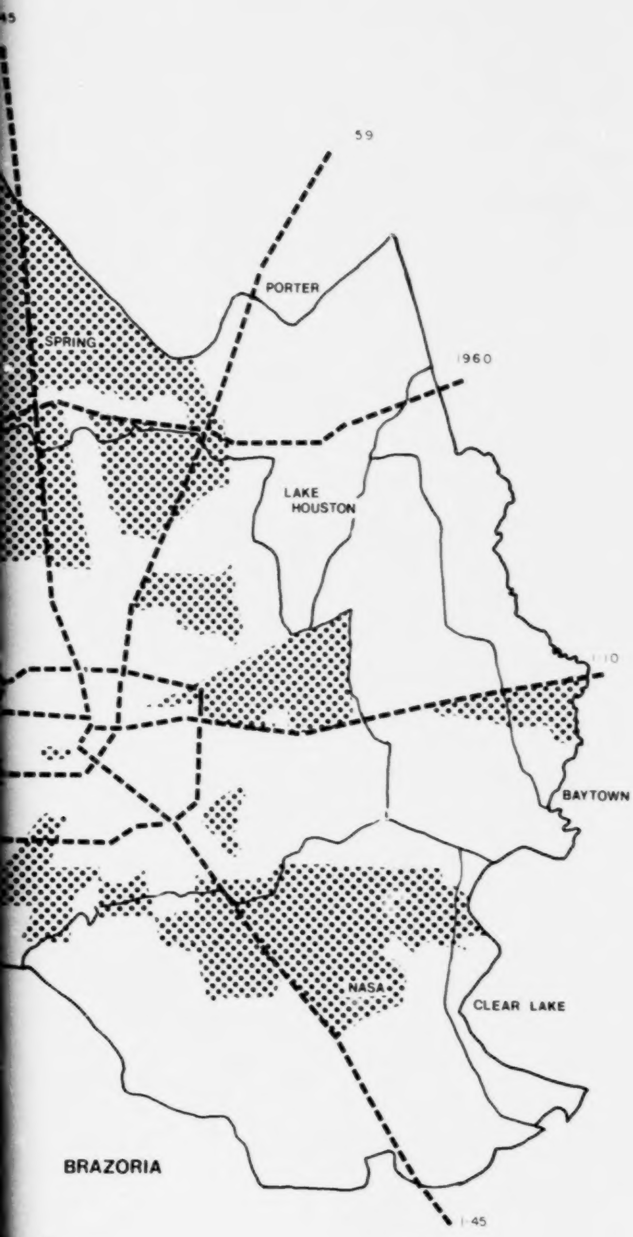
II-A-13

Environmental Assessment

COMMERCIAL

TOTAL ACREAGE CHANGE

▦ 100 & ABOVE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Management Plan

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

DRAWN BY: JAMES VELTMAN & ASSOCIATES inc.	REVISIONS BY:	EXHIBIT II-A-3 SCALE
DATE: 2-78	DATE:	SECTION

Industrial Growth

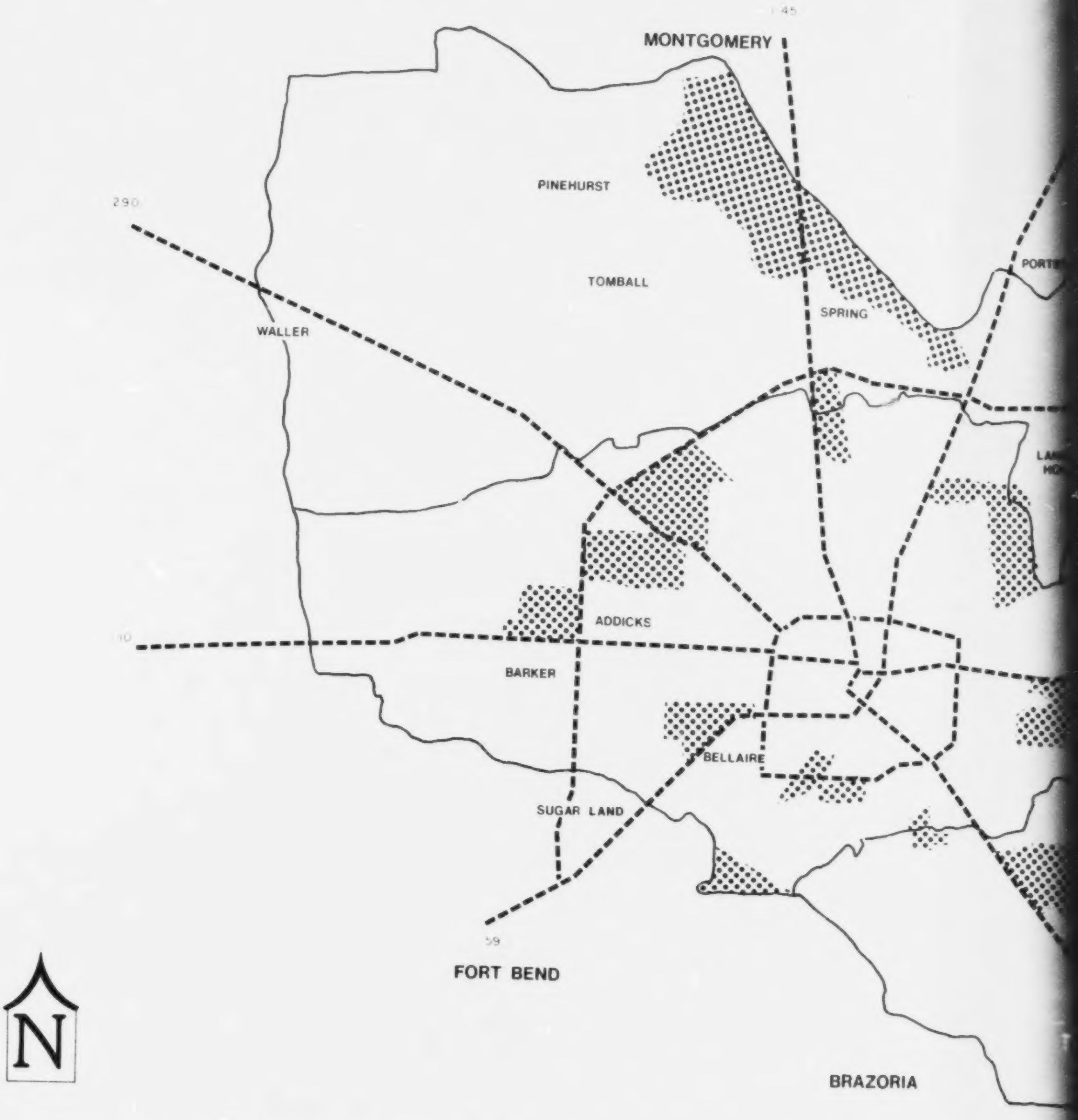
Total acreage change 1975-1995

The significant areas of change are considered to be increases of 300 acres or more because of the relative size of individual industrial tracts. The pattern that emerges for industrial growth is heaviest in the ship channel area and Ellington Air Force Base with Loop 610 south at Highway 288 and north Fort Bend County being the southern areas. The northern areas are generally defined by Addicks resevoir west, Highway 290 at FM 1960, FM 1960 and I-45 southeast, southern Montgomery County along I-45, south of Humble along Greens Bayou, southwest of Lake Houston and north of Baytown.

Houston Ship Channel and Tributaries

Industrial growth - acreage 1975-1995

Census Tract	%	Acres		Location
329	621	612.0		Loop 610 at Hwy 288.
331	542	467.8		Loop 610 at Astrodome.
423	283	300.1		Highway 59, west of Loop 610 to Richmond Avenue
424	141	310.9		
701	3772	375.0		Northern Fort Bend County.
344	362	554.4		Hobby Airport South.
450	625	375.0		West of Addicks Resevoir.
542	148	305.0		Hwy 290 at FM 1960 and Southeast.
541	200	350.0		
535 p	576	375.0	partial	I-45, east side from Greenspoint Mall to Halls Bayou.
533	4000	300.0		
238	1857	650.0		Hwy 59 at Humble and east along Greens Bayou to west of Sheldon Reservoir.
236	960	600.0		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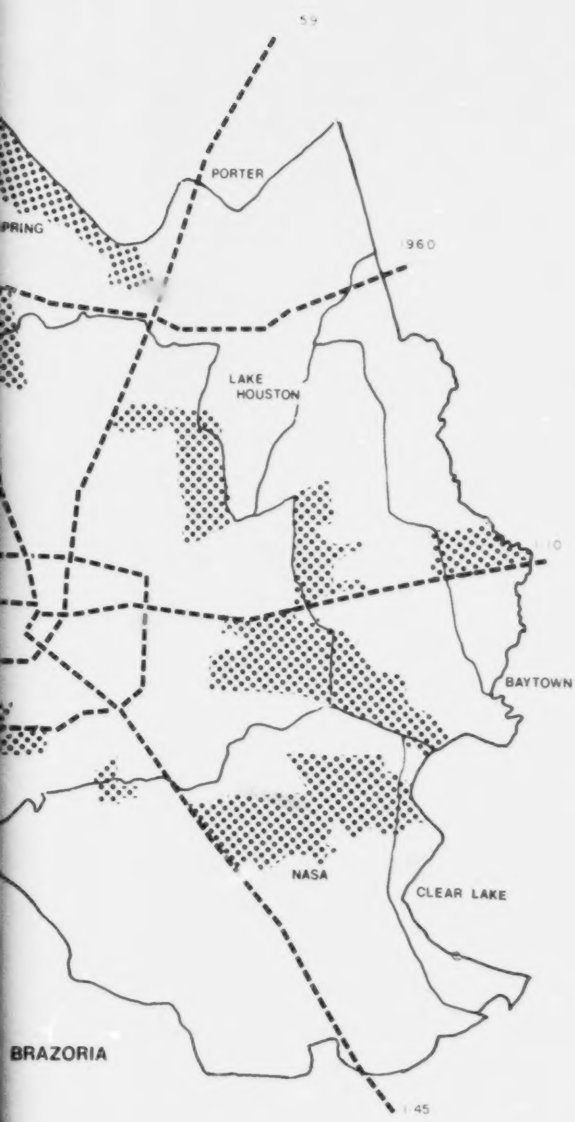
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Environmental Assessment

INDUSTRIAL

TOTAL ACREAGE CHANGE

▨ 300 & ABOVE

HGAC	GREATER HOUSTON 208 PROGRAM HOUSTON-GALVESTON AREA COUNCIL	
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Census Tract	%	Acres	Location
235	59	400.0	Southeast of Lake Houston to I-10.
260	100	334.0	North of Baytown, north of I-10.
364	1000	600.0	South side of the ship channel from Galveston Bay to Washburn Tunnel.
362	98	750.0	
361	27	650.0	
354	146	650.0	
233	111	725.0	
352	33	345.0	

Lake Houston and Tributaries

Industrial growth - acreage change 1975-1995

Basically only two areas show as significant and they are census tract 902 with 1267% increase with total acreage change of 380.0 acres and is located along I-45 in southern Montgomery County; Census tract 535 with 576% increase with total acreage change of 375.0 acres and is located at FM 1960 and the southeast corner of I-45.

Clear Lake SubBasin

Industrial Growth - acreage change 1975-1995

Only one area of significant change occurs and is the census tracts 370, with 88% increase and 1757.0 acres, and 366, with 141% increase and 1505.0 acres, better defined as Ellington Air Force Base and east in the northern Armand Bayou watershed.

Agricultural Growth

Total acreage change 1975-1995

As one would expect in an urbanizing region such as the Greater Houston planning area, very little growth occurs in agricultural land use. The major phenomena is a reduction of agricultural acres although some small increases do occur in north and southeast areas of the planning area. It is not known what types of agriculture these increases are but the areas that demonstrate the decreases are in areas of significant single family, multi-family, commercial and industrial growth. The majority of the decreases occur in the Houston Ship Channel and Tributaries.*

Houston Ship Channel and Tributaries

Agriculture. Areas of significant change 1975-1995, 100 acres or more. Negative growth.

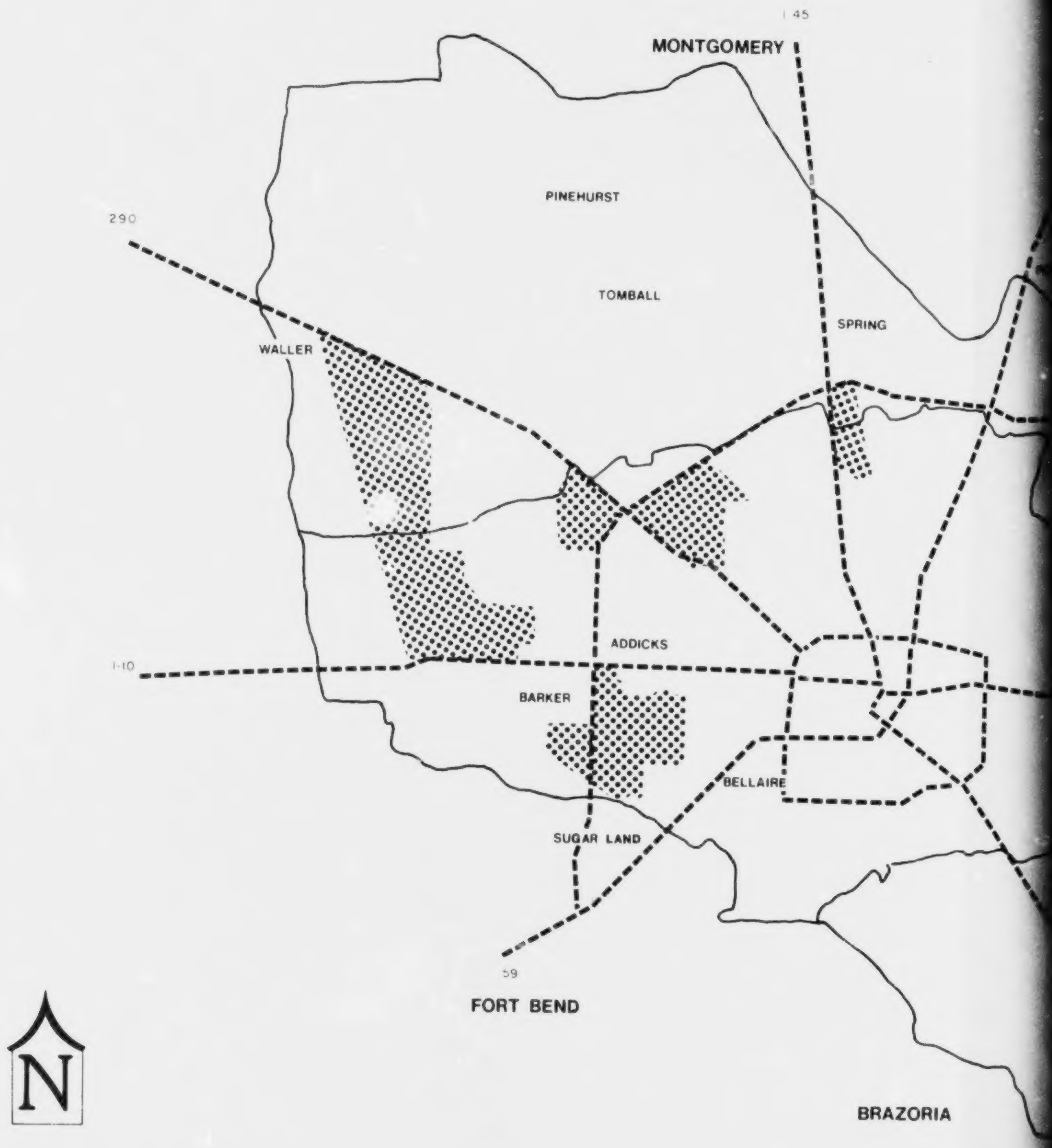
Census Tract	%	Acres	Location
452	(4)	787	East of Katy towards Addicks Reservoir.
438	(21)	2294	Southwest of Barker Reservoir.
437	(2)	183	
544	(1)	140	FM 1960 @ Hwy 290 east and west.
541	(2)	236	
535	(8)	415 partial	I-45 east--north of Greens Bayou.
229	(7)	320	South of Sheldon Reservoir.
262	(9)	194	North Baytown south of I-10.
260	(3)	209	

Lake Houston SubBasin

Agriculture. Areas of significant change 1975-1995, 100 acres or more. Negative growth.

Census Tract	%	Acres	Location
547	(0)	119	Southeast of Waller.
535	(8)	415 partial	Greenspoint Mall south along I-45.

*Note: It should be mentioned that in census tracts outside Harris County, the vacant and agricultural categories are totaled and reported as undeveloped.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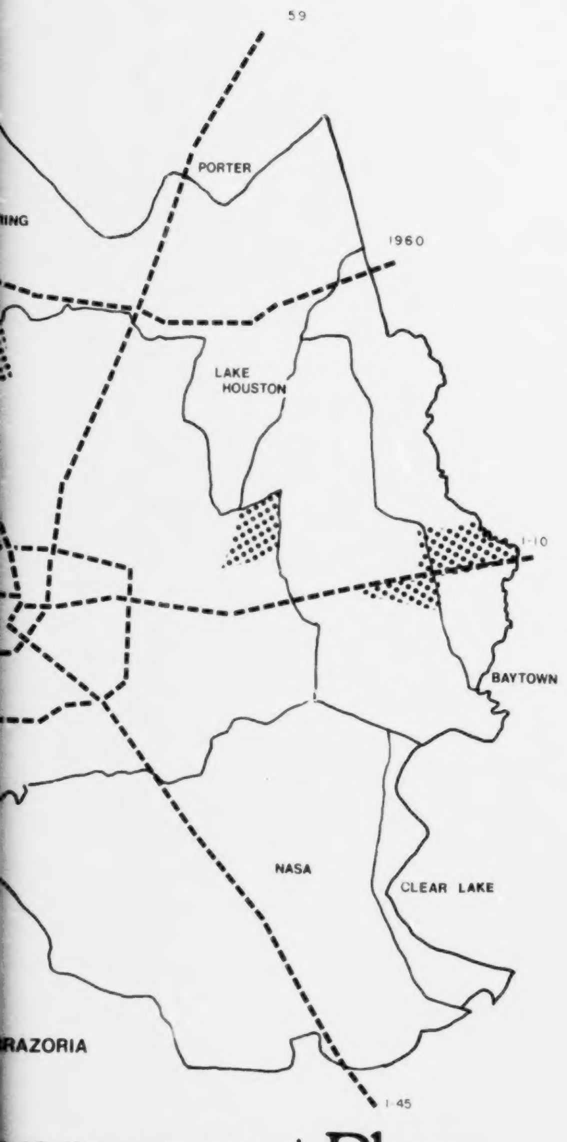
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Environmental Assessment

AGRICULTURE

TOTAL ACREAGE CHANGE

▨ [100 & ABOVE]

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

DRAWN BY: JAMES VELTMAN & ASSOCIATES inc. DATE: 2-78	REVISIONS BY: DATE:	EXHIBIT II-A-5 SCALE SECTION

Open Space

Total Acreage Change 1975-1995

Very little increase in open space occur in the projections with the majority of the census tracts showing zero or less than 25 acres. Three tracts show significant increases of more than 100 acres. They are:

Census Tract	%	Acres	Location
371	119	213	West of Pearland
329	538	223	Hwy 288 south of Loop 610 at Pierce Junction.
213	101	167	Jacinto City.

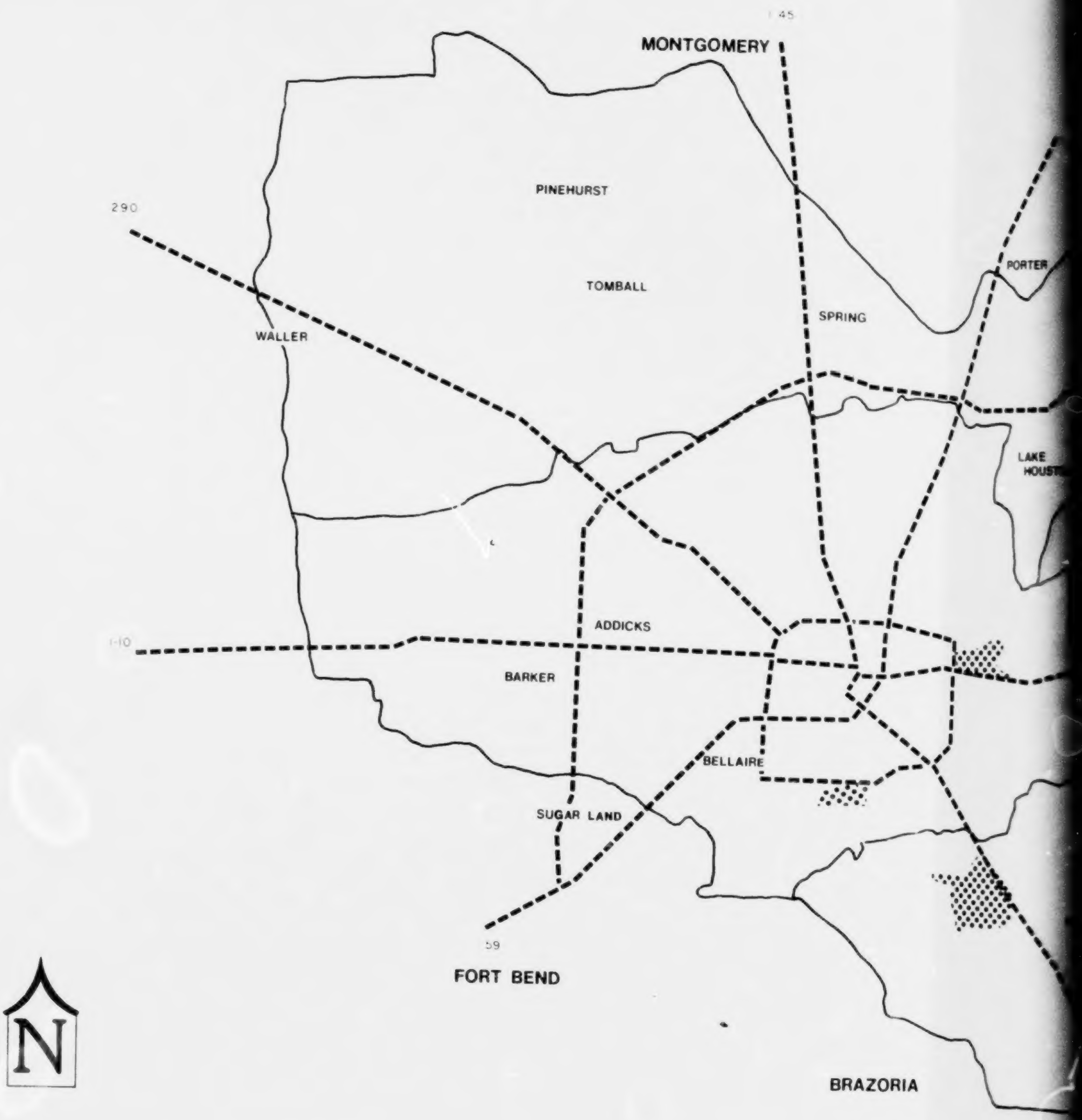
The decreases again relate significant growth tracts and are all in the Houston Ship Channel SubBasin. They are:

Census Tract	%	Acres	Location
423	(84)	37.1	North of Sharptown
307	(77)	30.8	Hwy 288 north of Brays Bayou.

Vacant and Undeveloped Land

Total Acreage Change 1975-1995

The only real significant change in the vacant land categories is a reduction of acreage. It occurs in all watersheds and subbasins with the majority of the decreases occuring in the areas of significant growth.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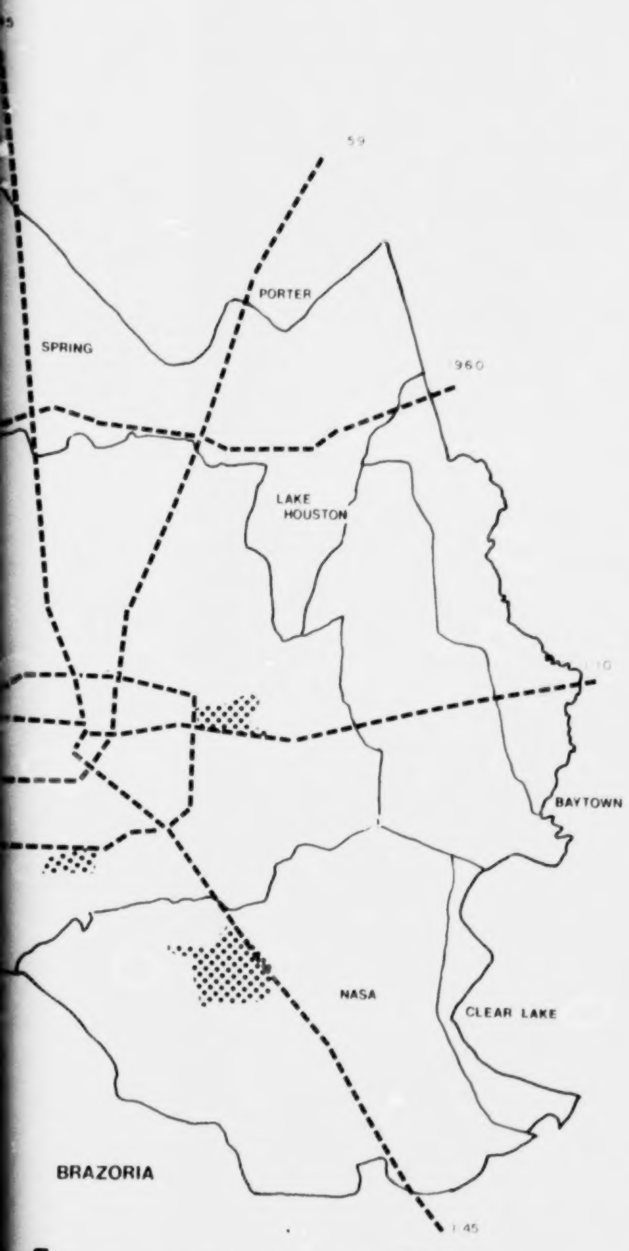
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Environmental Assessment

OPEN SPACE

TOTAL ACREAGE CHANGE

▦ 100 & ABOVE

Management Plan

HGAC **GREATER HOUSTON 208 PROGRAM**
HOUSTON-GALVESTON AREA COUNCIL

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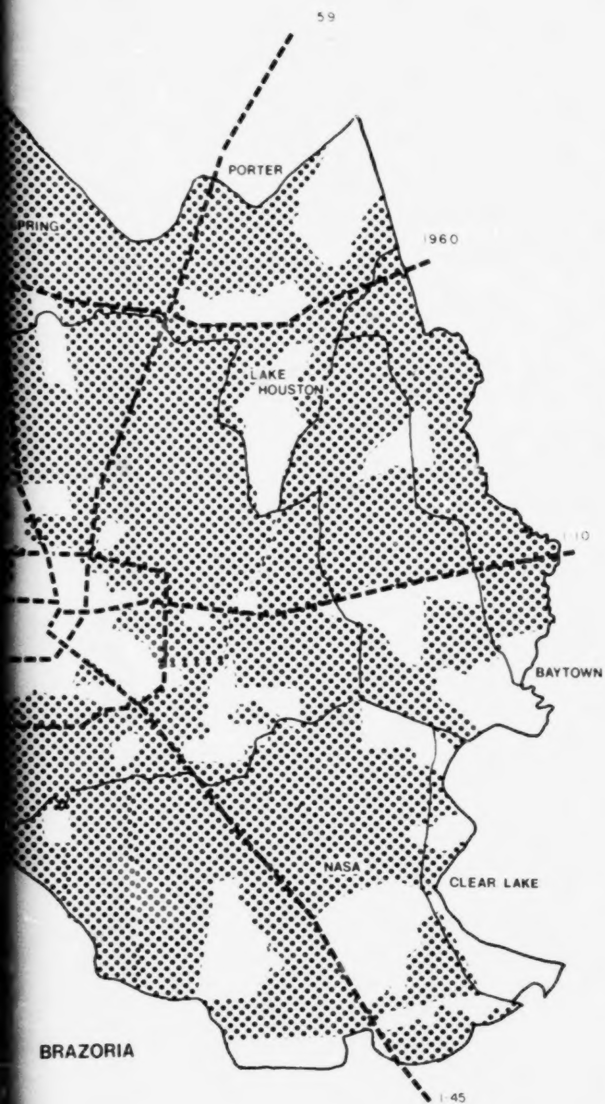

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Environmental Assessment

UNDEVELOPED

TOTAL ACREAGE CHANGE

▨ [100 & ABOVE]

Management Plan

HGAC GREATER HOUSTON 208 PROGRAM HOUSTON-GALVESTON AREA COUNCIL		
DRAWN BY: JAMES VELTMAN & ASSOCIATES inc. DATE: 2-76	REVISIONS BY: DATE:	EXHIBIT II-A-7 SCALE SECTION

Description of the Implications of Growth Without the 208 Water Quality Management Plan.

The implications of growth without the 208 plan could be significant. The plan recommendations strongly address the problem of insufficient nonpoint source data or models by which to evaluate the problem. The report on "Control Strategies, Costs and Impacts for Nonpoint Sources" identifies the major problem and potential impact. It states....

"Urban runoff is the surface runoff of stormwater within an urban area. The flow of stormwater through the atmosphere, across the yards and paved surfaces, off the roofs of homes and buildings and through the parks, fields and ditches picks up and carries to the receiving streams several types of pollutants generated within the urban subcatchment. Research on the characteristics of urban runoff pollution indicates the seriousness of the problem has been highly underrated. Appreciable contaminants measured as suspended solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrogen forms, phosphates, hydrocarbons, soluble metal compounds, total bacterial counts, coliform and fecal enterococci indicate that urban runoff can degrade the quality of a receiving stream as a pollutant comparable to bypassed flow from combined sewers, or raw sanitary sewage, in certain cases. Discharges from separate storm runoff collection systems are preferable to those from combined sewer overflows; but the total pollutional load to receiving streams by urban storm runoff is still staggering."

If one assumes that the 208 program were not to exist and that development will continue at existing and projected rates it is only fair to assume and assess the impact without the 208 program as follows:

1. Current subdivision platting standards do not address the problems of wet weather pollution and this would continue. The rate of suspended solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD), etc. will have to be implied or assumed from other sources such as the Tulsa, Oklahoma, data base. From this information it would be safe to assess that the wet weather quality of the water in the streams would continue to degrade and produce continued increases in the pollution loadings on the stream.

2. Vegetation control techniques may continue to gain popularity due to pressures from environmental groups, continued increases in construction costs and continued enforcement of the 100 year flood plain. This concept, if continued without the 208 program would assist in the potential improvement of the water quality but is not considered to be a total solution to

the problem. Continued studies by a 208 type program would definitely assist in collection and evaluation of data relative to this phenomena.

3. Erosion control of construction activities without the effective studies and accurate data required is not considered to be a very implementable concept in the 208 planning area. Some agency or planning unit will need to be the enforcer of standards and or controls. Without the continued efforts of 208, this consultant sees no agency preparing to take this role, thus the impact will continue and will be significant.

4. Without the 208 plan continuing in time all the non-point problems should be considered to be serious problems and the impacts, in the consultant's opinion, will be severe.

5. The recommended plan, relative to point source pollution, shows one good side to environmental impact. Assuming the same basic parameters as are presumed in the preferred plan, the impact of growth will be controlled by the regulatory agencies that issue the discharge permits. Assuming continued monitoring of these discharges and continued attempts to improve point source treatment, the impact of the future growth without the 208 plan would be slight. This does assume that all point source dischargers are meeting and will continue to meet their permitted levels.

6. One of the major impacts of growth that will affect the Houston region in areas of growth will be the impact of land development on the wildlife habitats. It is anticipated that wetlands will continue to be drained, the prairies will continue to develop and agricultural land use will diminish in size to accommodate the growth patterns. Erosion will then continue, increased peak flows will continue to become higher and the need for more structural or non structural drainage "improvements" will increase. As this need increases the water tolerant hardwoods along the creeks and bayous will be subject to increased flows and flooding causing increased attempts at channelization. This process if continued will, in fact, continue the degradation of the unique habitat and cause a significant impact on the wildlife habitats in the Cypress Creek, Buffalo Bayou and Lake Houston watersheds.

As can be seen, the emphasis of the implications of growth without the 208 plan stresses heavily the same items needing further study and data collection. Because the major projected growth occurs and is concentrated from the northeast to the southwest, all major watersheds are affected. In particular the areas of most impact are described as:

1. Upper Buffalo Bayou watershed - The area defined by Addicks/Barker

reservoirs to the city of Katy and north and south.

2. North to northwest Houston, Greens Bayou and Cypress Creek. (East and west of I-45).

3. North west of Lake Houston, in the vicinity of Humble.

4. North of Baytown, along I-10.

5. West of Johnson Space Center - Clear Creek Basin to south of Loop 610, south of the Astrodome.

CHAPTER II-B
DEMOGRAPHIC CHARACTERISTICS

Introduction

As with land use the source of information on demographic characteristics is the Houston-Galveston Area Council document "Population, Land Use for the Greater Houston 208 Area", dated April 1, 1977. Other data also utilized was the H-GAC data base on employment by census tract. For assessment purposes the key factor analysed was the percentage of change by planning period and basin.

Planning for short term and long range water quality requires detailed analyses of both existing population and projected population totals. Local governments must have some estimate of future demand for services in order to prepare for future facility needs. This is especially true for areas which have substantial growth of population through the years.

Population estimation is really an attempt to attach a number to a flow of people through time. Population in all areas ebbs and flows with the movements of new people into the area and the movements of people out of the area. Where these two counter flows are approximately equal and exist at the same time, population estimates can be made fairly easily. When the ebbs and flows are not of the same size nor coincident, the dynamics of population movement must be understood to proceed with population estimation. In areas where there are large amplitudes to population totals; facility planning becomes especially difficult. Most published population analyses ignore this dynamic aspect of population estimation and thus, do not provide sufficient information to local governments for planning purposes.

The Houston-Galveston Area has had very large increases in population during recent years, which makes population estimation more difficult. The estimates and projections also need to be seen in light of the capabilities of the land to withstand the growth that will occur. In the section on Biology, many factors become important to future growth of Houston but population and employment projections are not site specific. Thus, the following demographic characteristics are the generators of land use. This land use as previously described, is the major cause of environmental and economic impact. This impact will become site specific in future detail studies.

This brief discussion of the purpose and place of the demographic data should place in perspective the importance of this data in the assessment of the Greater Houston Waste Treatment Plan. It should also stress the importance of each individual areas growth to the overall concept of continued quality in both natural and economic environments. It should be stated that economic growth does not need to impair environmental quality or visa versa. It is the firm belief of JVA that growth decisions must be comprehensive. These decisions, related to development, require the understanding of man's impact upon the ecosystem within which he lives. Decisions relevant to individual projects form the basis of man-made environments. The collection of these small scale environments form the basis for urban growth. The aggregation of urban areas constitutes the form of the city and the grouping of these cities results in the developmental form of the region. They are interrelated and continually changing. The man-made environments and the ecosystem are interacting phenomena. Responsible planning begins with a knowledge of the land, the organisms that use the land (this includes man and his requirements as a social being) and the economic conditions within which he operates.

Areas of Significant Change (Percentage Growth)

Employment

The major attempt in this section is to identify the areas where major changes are projected and growth will occur. Because the base data is of 1974 origin, absolute numbers were not utilized in their entirety. The method undertaken was one of percentage growth by planning period and employee growth over 500 employees. The areas selected by number of employees are designated by an asterick. The first five years of information is always the most definite or most easy to project and thus, most detailed.

1975-1983 Employment (75% or more, or 500 Employees or more)

The specific areas that stand out in terms of 75% or more change between 1975 and 1983 are census tracts 704, 449, 452, 450, 541, 599, 246, 262, 364, 371, 342, 339, 337, 329, 332, 428, 419, 434, 435, 451, 336, 338.

*Areas of 500 employees or more are:
126, 210, 218, 232, 233, 236, 261, 262, 274, 301, 307, 309, 311, 316, 319, 320, 322, 325, 329, 330, 331, 332, 334, 338, 339, 344, 346, 347, 354, 359, 366, 370, 371, 373, 402, 404, 414, 419, 420, 423, 424, 425, 428, 434, 435, 438, 442, 443, 444, 447, 503, 509, 511, 516, 517, 529, 533, 534, 535, 538, 541, 542, 558, 701, 704, 540.

Generally, these areas can be described by watershed and location and are:

Houston Ship Channel and Tributaries (75% or More)	Location
704, 449, 452, 450, 451	Katy Freeway from Katy to Addicks and Barker Resevoirs.
435, 434, 428	NE of Stafford on Hwy. 59 (Bissonett and 59 Area)
419	Loop 610 at Hwy. 59 South
262	Interstate 10 just West of Burnett Bay, North of Baytown.

Houston Ship Channel and Tributaries (*500 employees or more)	
126	I-45 @ Buffalo Bayou inside Loop 610.
210, 301, 311, 309	Inside Loop 610 along ship Channel
307,316, 404	I-59 and south along Hwy 288.
402	West of Downtown Houston
503	I-45 at I-10 eastside
509, 511	I-45 at Loop 610, southeast corner and southwest corner.
516, 442, 517 443, 447, 542, 529	I-10 from inside Loop 610 out to Addicks Resevoir, North of I-10.
420, 423, 419, 424, 425, 435, 434	Hwy 59 from Loop 610 to the Harris County line.
414, 331, 330, 329, 339, 332, 338	Astrodome at 610 Loop south along Hwy 288
428	Southwest of Bellaire

334, 701	Northern Fort Bend County and north of Mayfair Park
704, 438	Southwest of Barker Resevoir
541, 540	Hwy 290 at FM 1960
534, 533	I-45 Between Greens and Halls Bayou.
236	East of Greens Bayou, West of Sheldon Resevoir
232, 233, 254, 322	Ship Channel from Loop 610 east
262, 261, 274	North Baytown and Baytown south.

Lake Houston SubBasin (75%)	Location
559 and Surroundings (50 - 75%)	I-45 and Spring (East), North of Cypress Creek
246	Between Humble and Lake Houston, South of FM 1960 West of Atascocita

Lake Houston SubBasin 500 Employees or more	
535	I-45 eastside, south of Greenspoint
538	FM 1960 between Hwy 149 and Stuebner Airline
558	I-45 Westside, North of Cypress Creek

Clear Creek SubBasin (75%)	Location
336,337, 338	Almeda and area East of 288
342	North of Pearland
371	West of NASA

In general the areas of significant growth of employment are spatially located in a "C" shaped ring on the edge of existing population with the major concentrations being south, west and north along I-45 and 59, I-10 and I-45 and 59 North.

Clear Creek SubBasin 500 employees or more	Location
344, 346, 347, 359, 371, 370, 373, 366	Ellington Air Force Base East and West and South to Johnson Space Center

1983-1990 Employment

During the time frame of 1983 to 1990 the percentage of growth is less extreme with the majority of the census tracts demonstrating 0-25% growth, but with the previous areas of significant growth continuing at a percentage of 25-50%, except for the tract 704 which is Southwest of Barker Reservoir and North of Richmond. Katy to the Addicks-Barker Dams continues at 25-50%, along with Spring-1960 East continuing. In the Clear Creek watershed the tract 371 (West of Ellington Air Force Base) also continues at 25-50% growth.

The tracts of 500 employees or more are 236, 262, 307, 329, 330, 331, 338, 346, 347, 360, 402, 419, 423, 424, 428, 434, 435, 503, 529, 534, 542, 704, 701. These major concentrations are all basically in the Ship Channel and Tributaries concentrating along Hwy 288 south of Loop 610, Hwy 59 and South, Hwy 290 in North Houston area, and west of Sheldon Resevoir.

1990-1995 Employment

The majority of the projections during the final years of the planning period fall into the range of 0-25% increase with one selected tract showing some decline. Except for these areas all others are areas of 25-50% growth and are scattered in 5 tracts throughout the 208 area.

The areas of 500 employees or more are 262, 267, 338, 346, 360, 402, 419, 434, 503, and 704. These concentrations are defined by south of Hobby Airport, North Baytown, Loop 610 at the Astrodome, south along Hwy 288, I-59, southwest of Loop 610, East of Downtown, North of Downtwon and Northeast of Barker Resevoir to Hwy 290.

1975-1995 Employment (Total Planning Period)
75% or more

As a total growth pattern over the twenty year span we see a similar pattern as indicated on the 1975-1983 period.

Houston Ship Channel and Tributaries	Location
704, 705, 449, 450, 451, 452	Katy Freeway from Katy to Addicks and Barber Reservoirs, but extending northeast and southwest to
435, 434, 436	Northeast of Stafford on 59 (Bissonett and 59 area)
419, 402	610 Loop @ 59 South
262, 267, 261	North Baytown and North @ I-10
503	Hwy 59 @ Loop 610 North
226, 227, 229, 236 partial 238, 241	Greens and Halls Bayou to Hwy 59
329, 332, 701, 334, 337, 338, 342	610 Loop, Astrodome south along Hwy 288
344, 346	I-45 south near Hobby Airport
354	Ship channel area @ I-10
364	West of Baytown
428	Bellaire
443	Hwy 290 @ North Houston
518	I-45 northwest of 610 Loop
529, 534, 541, 535, 536, 538, 540	1960 south between Hwy 290 and I-45

Lake Houston Subbasin	Location
559, 902, 535, 534, 558, 536 538, 556, 541	1960 & I-45, north into Montgomery County and west along Cypress Creek

Clear Creek Subbasin	Location
337 and vicinity	Almeda and area south of Astrodome
371, 372	Johnson Space Center area and west
1205, 1208	North Galveston County

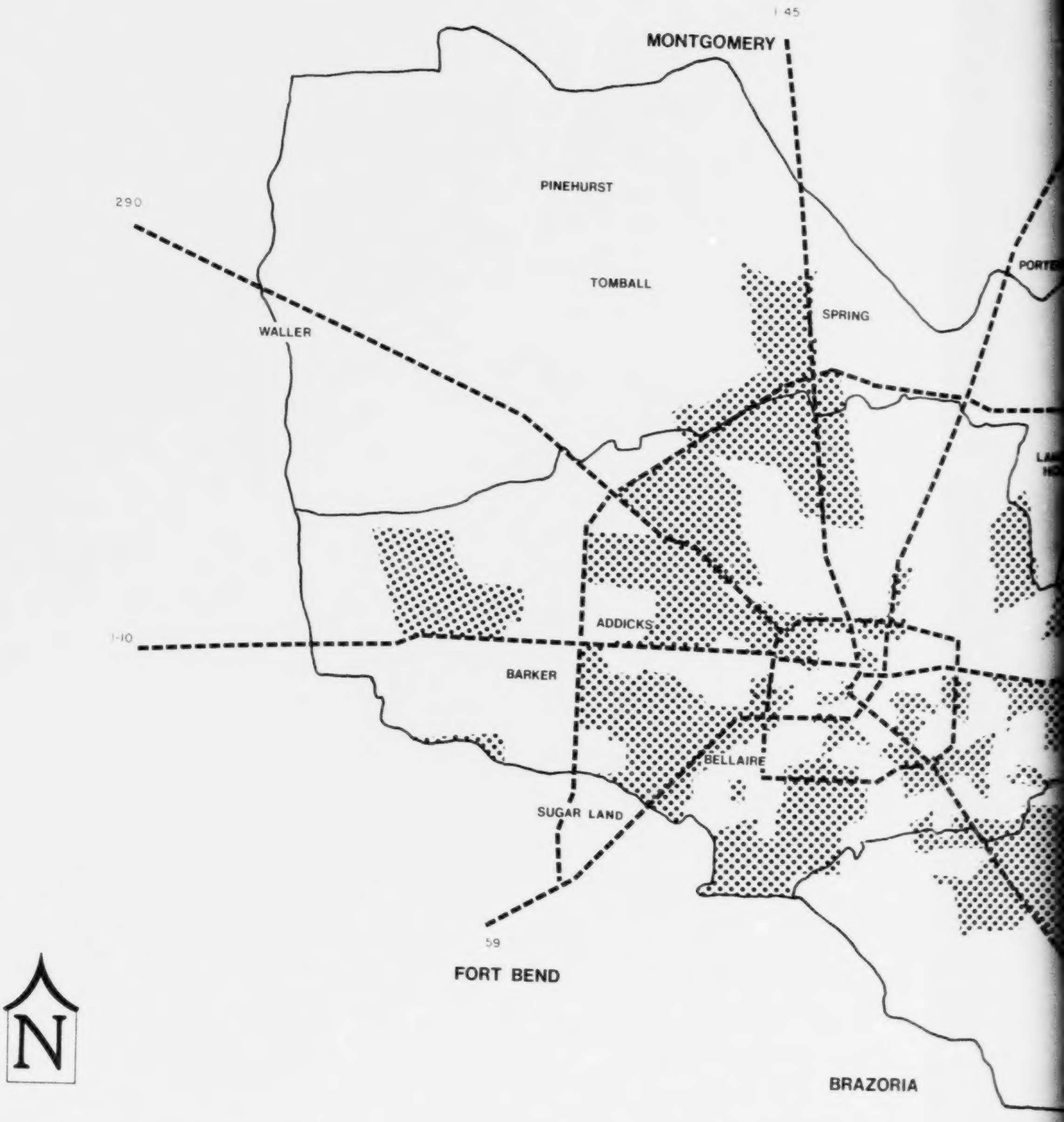
1975-1995 Employment (Total Planning Period)
500 Employees or more

Houston Ship Channel and Tributaries	
126, 503	West and north of Downtown
509	I-45 @ 610 Loop north and west
207, 218	Hwy 59 @ 610 Loop north
307	Hwy 59 @ ship channel
301	East of Downtown then west along Hwy 59
229, 232, 233	I-10 east at ship channel and north
236	East of Greens Bayou
261, 262, 267	North of Baytown
274	Baytown
316	North of Astrodome
319, 325, 322	I-45 and 610 Loop south
329, 330, 331, 332, 334, 335, 336, 338, 339, 414, 701	Hwy 288, south of 610 Loop and Astrodome

344, 346, 347	South of Hobby Airport
356, 359, 360	North of Ellington Air Force Base
419, 420, 423, 424, 425	Hwy 59 @ 610 Loop west
428	South of Bellaire
434, 435, 436, 438, 439 442, 704	South of Barker reservoir to Hwy 59 west of Loop 610 west
444, 447, 542	East of Addicks reservoir
452	East of Katy, north of I-10
517, 518	610 Loop @ Hwy 290
528, 529, 533, 534, 535, 536, 537, 540, 541	Hwy 290 @ North Houston to I-45, south and north of FM 1960

Clear Creek Subbasin (500 Employees or more)

336	East, north and west of Johnson Space Center


I 45
MONTGOMERY
PINEHURST
290
TOMBALL
SPRING
WALLER
PORTE
ADDICKS
I-10
BARKER
BELLAIRE
SUGAR LAND
59
FORT BEND
N
BRAZORIA

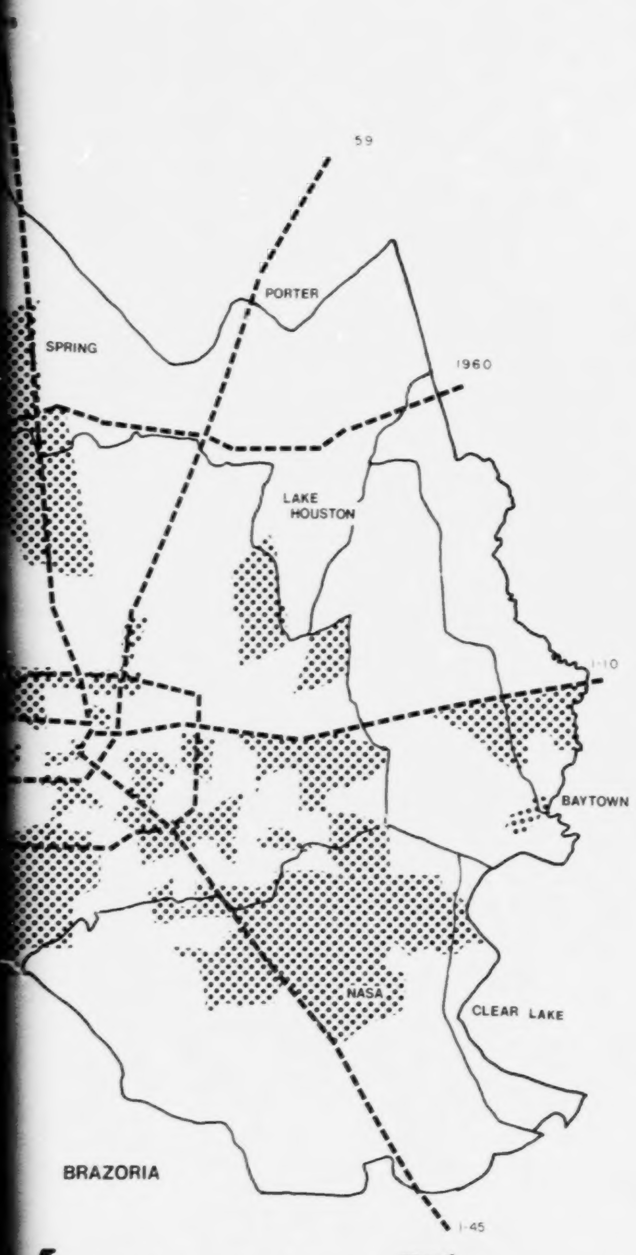
Areawide Waste Treatment Manageme

Environmental Assessment

EMPLOYMENT

TOTAL EMPLOYEES INCREASE

▦ 500 & ABOVE


59
PORTER
SPRING
1960
LAKE HOUSTON
I-10
BAYTOWN
NASA
CLEAR LAKE
BRAZORIA
I-45

Management Plan

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

DRAWN BY: JAMES VELTMAN & ASSOCIATES inc. DATE: 2-78	REVISIONS BY: DATE:	EXHIBIT II-B-I SCALE SECTION

Implications of Employment Growth Without the 208 Waste Treatment Management Plan

Employment growth has the potential of adverse impacts, over and above the items mentioned in the Land Use Section. Employment, as a category, covers industrial wasteload projections and nonpoint source potentials. Without the 208 planning effort, existing agencies and permit levels would continue and are assumed to be handling the monitoring of these permitted levels. The area of air-pollution does evolve and will be a secondary impact to the 208 plan but is a primary impact of growth itself. Such items as are contained in the "Nonpoint Source" reports then could be of concern. Briefly stated they are:

Shipping Activities
Dredging and Fill Activities
Air Quality
Oily Wastes
Construction Activities

Without the 208 planning effort, many employment activities will not be affected. Other than the land use activities affiliated with employment, it is hard to assess employment's impact without the 208 effort. Basically, the water quality would continue to be degraded, information necessary to establish the impact would not be generated, and the impact of employment might never be really known.

Introduction
Population

Population projection is the foundation for wastewater management. We stress the "interim" nature of these projections and the fact that they must remain the same during the duration of the initial study. We also stress the need for an update of the population as a priority item in continued planning activities. With these qualifications in mind, the projections were evaluated as percentage growth rather than absolute numbers. This approach stresses the areas of greatest change rather than absolute numbers. For the environmental assessment, this approach is sufficient especially in light of the fact that the plan is not a site specific plan but a goals, policy and management plan.

Areas of Significant Change
Population

Generally speaking, the areas of greatest population change (75% and above) occur in the west (Addicks Reservoir) vicinity and Northwest to North Quadrant during 1975 to 1983, with the north and south areas (Southern Montgomery County and Fort Bend County) continuing in time to carry the higher percentage growth. Along with this, is the infilling of areas directly adjacent to existing population along all edges of Houston. This is more specifically described in the section on total population growth and in the attached charts of population growth (see appendix), and the following map.

The specific census tracts of highest change between 1975 and 1995 which reflect an increase of 100% and above are 359, 370, 371, 372, 345, 346, 247, 344, 342, 602, 337, 338, 331, 332, 333, 334, 336, 432, 434, 436, 437, 438, 449, 450, 451, 801, 542, 447, 421, 261, 528, 544, 545, 541, 540, 529, 525, 530, 268, 539, 558, 551, 555, 556, 537, 534, 535, 517, 559, 903, 902, 901, 249, 247, 253, 226, 214, 213, 232, 538, 603, and 701.

These total tracts can be more specifically described by incremental growth and watershed as follows:

1975-1983 Population

Looking at the areas of highest percentage growth, the following zones begin to be areas of major or significant change. These zones are composed of the following tracts which reflect increases of more than 75% and are best described as:

Houston Ship Channel and Tributaries 1975-1983 above 75%	Location
438, 437, 449, 450, 451	East and West of Addicks and Barker Dams along I-10.
528, 529, 540, 541, 539, 534, 538, 537, 536, 535	From Jersey Village on 290 North and East to I-45 and Northwest to the southern side of Cypress Creek Watershed to I-45 with the highest percentile growth just East of I-45 near Greenspoint Mall

2-78

Houston Ship Channel Continued	Location
247	Along I-59 southeast from Humble, west of Lake Houston
213, 260	213 - Jacinto City 260 - North of Baytown, North of I-10
331	Astrodome and 610 South

Lake Houston Subbasin 1975 - 1983 above 75%	Location
551, 555, 558	Northwest side of Cypress Creek, east of I-45 to Hwy 149
Portions of 538, 537, 536	South side of Cypress Creek, East of I-45 to Hwy 149
902	Southern Montgomery County East and West of I-45
559	Spring, Texas. North of Cypress Creek, West of I-45
249	Northwest of Humble, East of I-59,
247	West of Lake Houston

Clear Lake Subbasin 1975-1983 above 75%	Location
370	Northwest of J.S.C., West of I-45
372, 375	Between city of Friendswood and J.S.C., West of I-45
344	West of Hobby Airport
337	Between Almeda and Hwy 288

Note: Only ten tracts show a negative population growth growth pattern and are located in the Houston Ship Channel basin.

1983-1990 Population

The percentage growth in population for this time frame shows a drop in percentage with the majority of the census tracts reflecting a drop in percentage up to 25%. The tracts that reveal the highest percentile growth are mainly in the 25-50% growth category, with a few tracts in the 50-75% range and only three tracts at 75-100%, with no census tracts above 100%.

Houston Ship Channel 1983-1990 25% and Above	Location
331(75-100%), 339, 338, 336, 334, 333, 332, 701	Astrodome (331) and South to Southwest of Loop 610 to Almeda
405	Greenway plaza, Hwy 59
438, 447	East of Addicks Reservoir and South of Barker Reservoir
421	I-10 @ Loop 610
121, 125	Downtown Houston
801	City of Katy and vicinity
528, 529, 530, 525, 517	Northwest of Loop 610 West along Hwy 290
516	I-10 inside Loop 610
226, 227	Intersection of Greens and Halls Bayou
434	East of Almeda outside Loop 610
214, 209, 213, 232	Loop 610 East @ L-10 and East along I-10
309	I-45 South, inside Loop 610

Lake Houston Subbasin 1983-1990 25% and above	Location
903, 902, 901	Southern Montgomery County from Pinehurst to Porter

Clear Lake Subbasin 1983-1990 25% and Above	Location
337, 341, 342 (75%), 344, 345, 346, 371	Southern Harris County from Almeda (Hwy 288) to I-45 south of Hobby Airport
602, 603	Northern Brazoria County
359, 370	North of J.S.C., along I-45

1990-1995 Population

Basically the same patterns occur during this time frame as occurred in 1983-1990; however,these patterns are more concentrated and the percentages drop in magnitude. Eleven tracts show negative population growth but the majority of the census tracts still indicate at least a 25% increase in population.

Houston Ship Channel 1990-1995 25% or more	Location
801	East of Katy, North of I-10
338, 336, 334, 333, 331	Astrodome and South to Almeda on the edge of Fort Bend County
438	South of Barker Reservoir
528, 529, 530, 517	Along Hwy 290, Northwest of Loop 610
121, 122, 201, 125	Downtown Houston and east along I-10
421	I-10 at Loop 610
214, 209	Loop 610 at I-10
233	Houston Ship Channel at Channelview
268	Northern Baytown

Lake Houston Subbasin 1990-1995 25% and more	Location
902	Southern Montgomery County at I-45

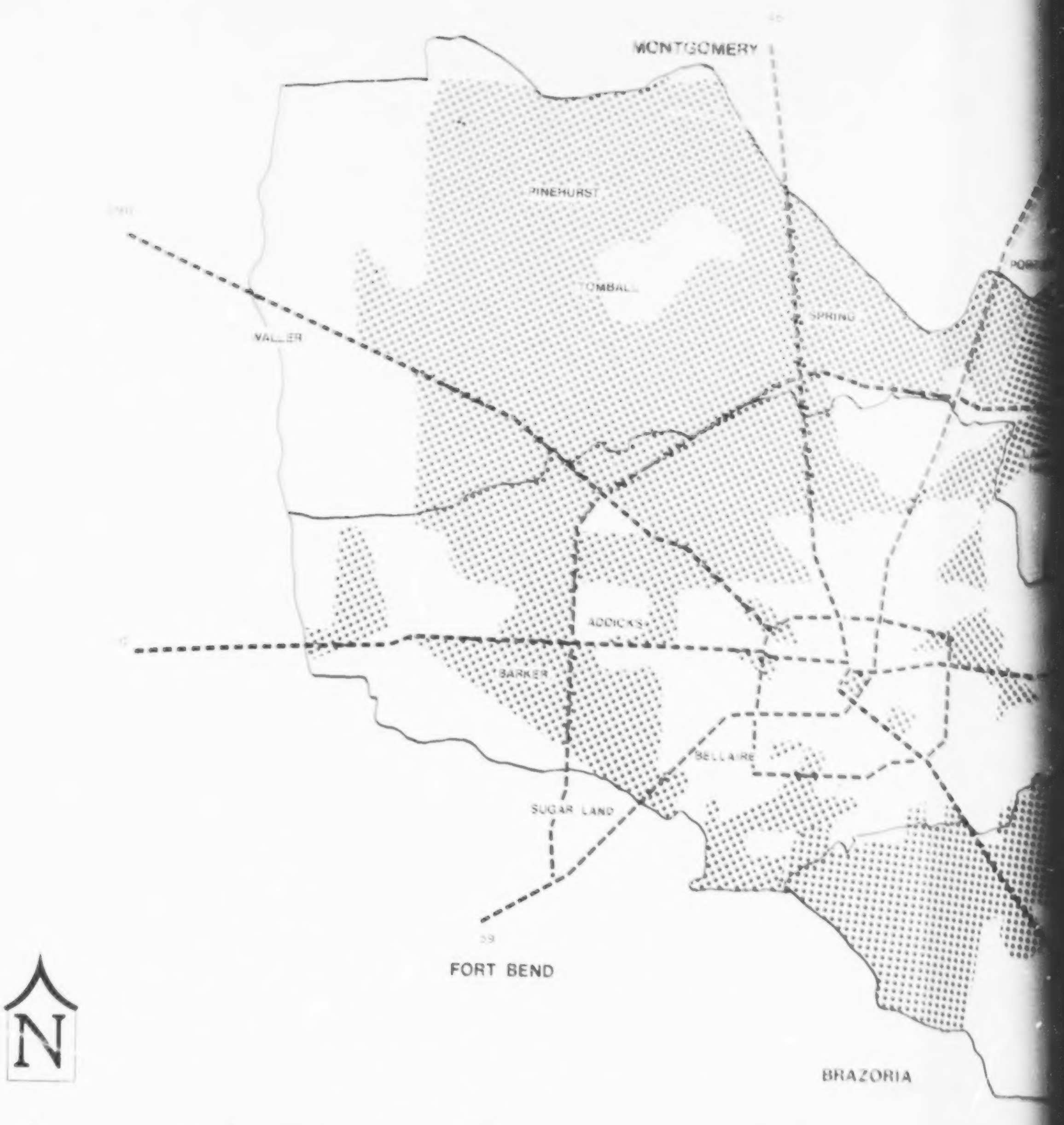
Clear Lake Sub-Basin 1990-1995 25% and more	Location
337, 342, 344, 346	South Harris County from Almeda to I-45, South of Hobby Airport
370	North of J.S.C., East of I-45

Total Population Growth-1975-1995

As a result of the various incremental growth patterns previously described, the overall pattern of growth reinforces the "C" previously mentioned with employment. Beginning at J.S.C. and progressing to Almeda, then to Addicks and Barker Reservoirs, progressing along F.M. 1960 to Spring and then to Lake Houston is the ring of highest percentile growth (100% and above) and is basically as described in the 1975-1983 growth pattern.

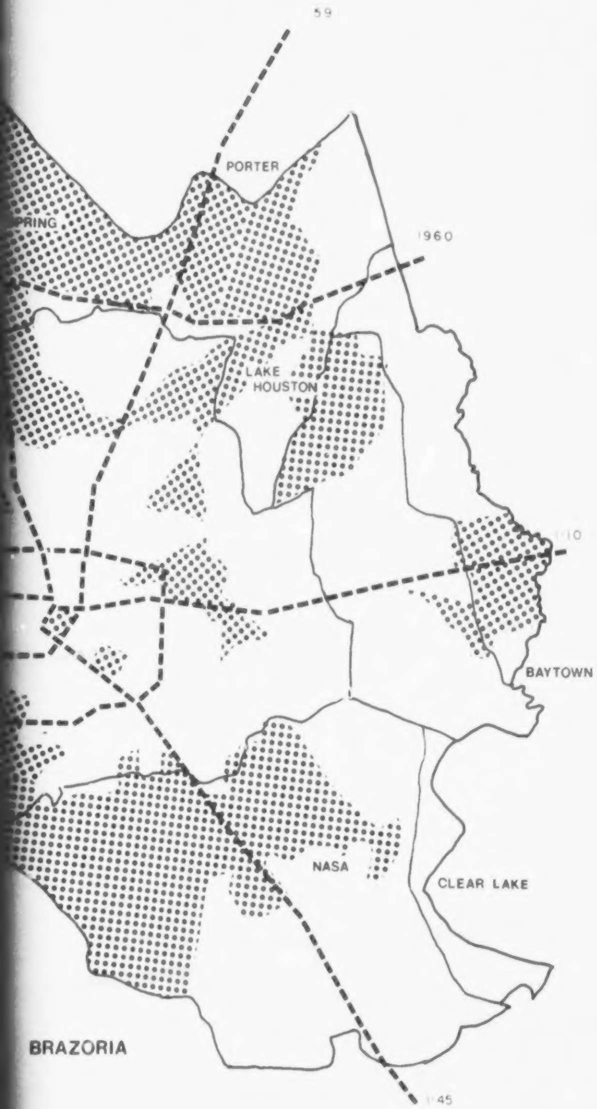
Implications of population growth without the 208 Water Quality Management plan.

Population growth is a function of many factors, some not even within the planning area nor in the state of Texas. It is hard to assess what the input on population growth would be without the 208 planning program. The growth in the past few years has continued and is expected to continue. The impact is created by the land use affiliated with this growth and is not expected to affect the rate or magnitude of growth within the 208 planning area.


45
MONTGOMERY
PINEHURST
290
TOMBALL
SPRING
WALLER
10
ADDICKS
BARKER
BELLAIRE
SUGAR LAND
59
FORT BEND
BRAZORIA
N

Areawide Waste Treatment Manageme

FI-B-6


59
PORTER
PRING
1960
LAKE HOUSTON
I10
BAYTOWN
NASA
CLEAR LAKE
BRAZORIA
I 45

anagement Plan

Environmental Assessment

POPULATION

PERCENT GROWTH

▨ 75% & ABOVE

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

DRAWN BY: JAMES VELTMAN & ASSOCIATES inc. DATE: 2-78	REVISIONS BY: DATE:	EXHIBIT II-B-2 SCALE SECTION

CHAPTER IIC
ECONOMICS

INTRODUCTION

The selected Waste Treatment Management Plan (208) will incur direct costs and will create indirect economic effects. Direct costs are those expenditures necessary to provide facilities, conduct research, or enforce regulations outlined in the Plan. Indirect economic effects include changes in land value or employment in response to policies designated in the Plan. This chapter describes a base from which to evaluate the economic consequences of the selected Waste Treatment Management Plan.

Current wastewater treatment standards are assumed as baseline conditions. The costs of compliance with presently effective municipal treatment standards set by the Texas Department of Water Resources are accepted as baseline costs. Existing federally established standards for industrial effluent are assumed as baseline conditions. These require use of Best Practicable Control Technology (BPCT) by 1977 and implementation of Best Available Control Technology (BACT) by 1984.

The description of current costs of wastewater control first examines direct costs. Estimated costs for municipal treatment projected 1995 waste loads are tabulated, indicating both total costs for the planning area and costs for each sub basin. Although cost estimates for industrial wastewater treatment are unavailable, flows within each sub basin are tabulated to indicate relative levels of expenditures for industrial treatment among basins. Presently, administrative expenses and financial incentives are the costs for voluntary non-point source control. Following the discussion of current levels of direct costs, mechanisms for the distribution of these costs are discussed.

Indirect costs of the selected 208 Plan will include effects upon land value and influences upon employment within the Planning Area. This discussion deals with relationships determining land value that may be affected by waste treatment and water quality decisions. Employment in the area will be affected if water quality standards should affect industrial output. Projected employment within sectors of the area economy is reviewed.

DIRECT COSTS

Direct costs are those costs incurred in the purchase, operation, and maintenance of structural pollution control systems and the costs of administration and enforcement of non-structural pollution control schemes. Even in the absence of an adopted 208 Plan, direct costs will be incurred in order to comply with current and presently proposed effluent standards. Estimates of the direct costs of municipal treatment under current standards and future wasteloads have been compiled in preparation of the Alternative Technical Subplans. Data is unavailable to estimate the direct costs of treating projected industrial discharge. In the absence of regulations governing control of non-point source run-off, direct cost of non-point source control is limited to administration of voluntary programs.

Municipal Treatment Costs

Costs for municipal treatment of future wast loads at present standards were estimated to represent costs of the existing system of wastewater treatment in the absence of a 208 Plan. Capital, and operation and maintenance costs for sewage treatment were estimated based on data provide in the Point Source Analysis report. This data was in turn based upon information excerpted from the National Commission on Water Quality publication number PB-250-690-03, dated March, 1976. Capital costs and operation and maintenance costs for sewage collection facilities are based on information developed for the Greater Houston Area 208 Program. These estimates of treatment and collection costs have been adjusted to present worth to facilitate comparison of alternative plans.

Costs determined for alternative plans are valid only for comparison of the alternatives and should not be interpreted to indicate user charges. Both because of limitations to the process of estimating costs and because of assumptions upon which the estimation is based, the costs represent only the gross economic commitment of alternative plans and not total or annual expenditures.

Assumptions

Present worth calculation assumes all future costs (capital, and operation and maintenance) are met by present expenditures. Using this method, future expenditures for alternative plans may be compared in terms of present dollars. In this way a measure requiring an expenditure of a given number of dollars ten years from the present is compared to a measure requiring the same expenditure at the present time. The amount of present dollars committed by scheduling a future expenditure is the amount that would acrue at a specified interest rate to the total required at the future date. An interest rate of 6.125 percent was used in calculating costs for the 208 Plan. The present worth calculation does not include the effect of inflation. This exclusion has a greater effect upon estimates of annually recurring operation and maintenance costs than on capital investments.

In order to facilitate analysis of alternatives in the (208) planning process, cost estimates have been based upon a generalized time table for construction of improvements. For analysis of future treatment under present standards capital expenditures for expansion and addition of treatment facilities have been assumed to take place equally each year from 1977 to 1995. Operation and maintenance costs for existing facilities are assumed to take place at a uniform rate through the 1977 to 1995 period. New facility operation and maintenance costs increase uniformly from zero to full value through the 1977 to 1995 period. The most accurate determination of costs would be based upon a detailed schedule of improvements. This accuracy has been compromised to enable evaluation of a greater number of alternatives.

The cost of treating future municipal waste loads under current permit standards was estimated using the same method used to estimate costs of alternative systems. The cost estimates are derived from generalized cost curves for each type of sewage treatment process. The estimates are not based upon current treatment costs specific to the 208 Planning Area. Existing plants are assumed to operate at their permit levels. The cost of realizing this assumption is reflected in the cost estimates. Base line estimates of municipal treatment costs, estimated for use in selecting the 208 Plan, are not comparable to present municipal treatment budgets.

Further assumptions regard the type and operations of waste water treatment plants. Information regarding existing plants was collected for the Point Source Analysis. The most critical item of information which is unavailable for a significant number of facilities is the existing treatment process. In such cases it has been assumed that the process is capable of producing effluent level 2. Information available about each plant does not differentiate between typical activated sludge and modified activated sludge(enhanced solids separation). The process in use has been assumed according to the effluent suspended solids requirement stipulated in the waste control order for each plant. These assumptions introduce an added margin of error to the base line cost estimates.

Cost estimates for future facilities assume all plants operate at 100% of capacity. This condition was assumed in order to phase installation of new facilities. All existing treatment plants are not presently operating at full-capacity. New plants and expanded facilities anticipated for the future will initally operate under-capacity. Because only a portion of operation and maintenance costs vary according to flow, costs per unit are higher for plants operating under-capacity. Operation and maintenance costs are therefore underestimated using the assumption of 100% capacity.

Areawide Cost

The base line projection of the cost of wastewater treatment for the (208) planning area totals $481,900,000 (present worth). This cost assumes present treatment standards and non-regional provision of services. In the accompanying table costs are presented according to basin and sub-basin. For each sub-basin the population served, number of plants, volume of flow, and water quality achieved are tabulated. Total treatment cost and cost per unit flow are listed. Cost per unit population is not presented because the present worth estimate does not lend itself to per capita comparison. Present worth sums costs over a period of time whereas population projections yield an estimate for a chosen point in time. Attempts should not be made to extract an annual user fee from the estimated present worth.

Spring Creek/Cypress Creek/Lake Houston Basin

The Spring Creek/Cypress Creek/Lake Houston Basin will be one of the most rapidly developing portions of the 208 Planning Area. The Basin's population is projected to reach 231,000 persons in 1995. Forty-four existing wastewater treatment plants currently treat approximately 6.1 million gallons per day. Ninety-one non-regional plants will be required to treat a projected flow of 24.8 million gallons per day. The present worth cost of treatment for the watershed is estimated to be $72,600,000, or approximately $2,930,000 per million gallons per day capacity. The high cost per unit flow is rivalled only by the cost of treatment in the San Jacinto-Tidal Sub-basin. In both cases treatment is provided by a large number of small plants. The average discharge per plant in this Basin is 0.27 million gallons per day.

Table II-C-1

Baseline Municipal Treatment Costs

	BASIN	1995 POPULATION	EFFLUENT SET	NUMBER OF TREATMENT PLANTS	1995 FLOW	WATER QUALITY ACHIEVED	COST	COST/MGD
1.	Spring Creek	72,000	2	32	8.51	III	21,700,000	2,550,000
2.	Cypress Creek	118,000	2N	49	12.11	I	44,100,000	3,640,000
3.	Lake Houston	41,000	2N	10	4.17	III	6,800,000	1,630,000
4.	Basin Subtotal	231,000		91	24.77		72,600,000	2,930,000
5.	Clear Creek - Nontidal	88,000	3NP	10	10.80	I	21,000,000	1,940,000
6.	Clear Creek - Tidal	38,000	3NP	6	5.90	III	12,400,000	2,100,000
7.	Clear Lake	60,000	3NP	4	1.01	III	7,800,000	7,770,000
8.	Armand Bayou	55,000	3NP	4	6.75	I, II	13,300,000	2,000,000
9.	Dickinson Bhyou-Nontidal	2,000	1	1	.18	I, II	600,000	3,330,000
10.	Dickinson Bayou-Tidal	29,000	2P	3	4.98	I	5,500,000	1,100,000
11.	Basin Subtotal	272,000		28	29.52		60,600,000	2,050,000
12.	Houston Ship Channel	176,000	2	11	20.02	II	18,500,000	920,000
13.	Buffalo Bayou	781,000	2	18	164	I, II	80,500,000	490,000
	Other Tributaries							
14.	White Oak Bayou	242,000	2	11	20.9	I, II	33,300,000	1,590,000
15.	Brays Bayou	460,000	2	24	60.7	I, II	49,800,000	820,000
16.	Sims Bayou	668,000	2	14	130.0	I, II	80,900,000	620,000
17.	Vince Bayou	108,000	2	3	7.9	I, II	7,900,000	1,000,000
18.	Hunting Bayou	38,000	2	5	5.8	I, II	5,200,000	900,000
19.	Greens and Halls Bayous	210,000	2	28	22.8	I, II	44,700,000	1,960,000
20.	Carpenter's Bayou	6,000	2	3	0.7	I, II	2,000,000	2,860,000
21.	Basin Subtotal	2,689,000		115	432.82		322,800,000	750,000
22.	Lower Ship Channel	included in Houston Ship Channel	2	11	-	III	18,800,000	-
23.	San Jacinto-Tidal	21,000	2	10	2.39	III	7,100,000	2,970,000
24.	Basin Subtotal	-		21	-		25,900,000	-
25.	Total	3,213,000		256	489.5		481,900,000	980,000

WATER QUALITY LEVELS:

Level I. The water quality that will result from continuing future operations at the existing permitted level of treatment.

Level II. The water quality standards adopted in January 1977 by HGAC through a combined effort of citizens workshops and advisory committees. These criteria are known as the 1977 standards.

Level III. The water quality standards adopted for implementation in 1983 which are capable of meeting the defined goal of "fishable/swimmable" streams.

Clear Creek/Clear Lake Basin

The Clear Creek/Clear Lake Basin is projected to have a 1995 population of 272,000. Twenty seven existing plants treat a flow of approximately 15.6 million gallons per day. The projected 1995 waste water flow of 29.5 million gallons per day is expected to be treated by twenty-eight plants. The total present worth cost for municipal treatment in this basin is $60,600,000 or $2,100,000 per million gallons per day capacity. The basin's projected municipal wastewater flow is higher than in the Spring Creek/Cypress Creek/Lake Houston Basin. Treatment standards are also higher in this basin than in the Lake Houston Basin, requiring use of a more expensive treatment process. However, the average flow per treatment plant is approximately 1.1 million gallons per day, roughly three times that of plants in the Lake Houston Basin. As a result, both total costs and unit flow costs for treatment are lower in the Clear Lake basin than in the Lake Houston Basin.

Upper Houston Ship Channel Basin

The Upper Houston Ship Channel Basin is the most populous section of the 208 planning area containing the City of Houston. The Basin is projected to have a 1995 population of 2,689,000 persons, 84% of the population of the planning area. The current waste water flow of approximately 228.7 million gallons per day is treated in 121 existing treatment plants. The cost of the 1995 system has been estimated assuming treatment of the projected flow, 432.8 million gallons, in 115 treatment plants. The total present worth cost for the basin is $322,800,000, yielding an approximate unit cost of $700,000 per million gallons per day capacity. This cost is substantially lower than unit costs in the other basins within the 208 Planning Area. The volume of treatment per plant in this basin is far higher than in others, averaging 3.8 million gallons per day. The presence of the City of Houston's Northside/69th Street Complex and Almeda Sims plant in this basin, both regional plants, certainly affects the average flow per plant. However, whether or not costs are evenly distributed in the basin, the aggregate cost is the lowest in the 208 Planning Area. The water quality achieved under existing permit standards is consistently lower within this basin than in the other basins of the Planning Area.

Lower Ship Channel/San Jacinto River Basin

The Lower Ship Channel/San Jacinto River Basin is the smallest basin in the 208 Planning Area. The Lower Ship Channel has been aggregated with the Upper Ship Channel in the tabulation of existing plants, projected population, and projected flow. In the Alternative Technical Subplans treatment themes are developed for the Lower Ship Channel separately from Upper Ship Channel. The estimated total present worth cost for treatment in the basin is $25,900,000. Projected flow is available for the San Jacinto River-Tidal Sub-basin.

The estimated cost per unit flow is $3,000,000 per million gallons per day. Both in the Lower Ship Channel and in the San Jacinto River-Tidal Sub-Basin fishable and swimmable standards may be met under existing waste-water treatment standards.

Industrial Treatment Costs

Costs of industrial waste water treatment have not been tabulated in preparation of the Waste Treatment Management Plan. The Point Source Analysis does catalog industrial discharge according to basin and by SIC number. Assuming a correlation between volume of discharge and cost of treatment the relative cost of industrial treatment may be compared from basin to basin. Industrial discharge for each basin is listed in the accompanying table. Because the treatment required for industrial discharge varies according to the industrial processes involved, discharge according to SIC number is less useful for approximation of relative costs.

Current flow and BOD loads from industrial dischargers have been tabulated from the summary by sub-basin in the Point Source Analysis. Projected 1995 flow and BOD loads have been tabulated from the Summary Report.

Spring Creek/Cypress Creek, Lake Houston Basin

In the Spring Creek/Cypress Creek/Lake Houston Basin the only existing industrial discharge is in the Cypress Creek sub-basin. The current flow is 0.025 million gallons per day and the BOD load is 4 pounds per day. By 1995 industrial discharge in this basin is projected to fall to zero.

Clear Creek/Clear Lake Basin

In the Clear Creek/Clear Lake Basin substantial industrial discharge occurs only in the Clear Creek Tidal segment. The present flow recorded in that sub-basin is 0.4 million gallons per day and a BOD load of 14 pounds per day. The summary report projects 1995 discharge in this sub-basin as 0.7 million gallons per day. The tidal portion of Dickinson Bayou received industrial discharge at 0.086 million gallons per day and BOD at 7 pounds per day. This discharge is projected to increase to 0.2 million gallons per day and 9 pounds per day. No industrial discharges are recorded or projected in other sub-basins of the Clear Creek/Clear Lake Basin.

Houston Ship Channel Basin

The Houston Ship Channel Basin receives the heaviest industrial discharge in the planning area as well as receiving the greatest portion of the planning area's municipal discharge. The Summary Report aggregates the lower and upper Ship Channel with tributaries to present projected industrial discharge. These have been grouped together in the table for presentation of existing discharge as well. The lower Ship Channel currently receives the greatest volume of industrial outflow of any of the Planning Area's subbasins, 501.881 million gallons per day. Both the upper Ship Channel and Vince Bayou receive waste loads of approximately 150 million gallons per day, however, the BOD load in Vince Bayou, 8955 pounds per day, represents approximately 30% of the Planning Area's industrial BOD. The Summary Report projects industrial discharge only for the entire basin. Flow is projected to decrease to 717.2 million gallons per day and BOD to decrease to 20,779 million gallons per day. The decrease may be attributed to adoption of BAT treatment standards rather than to a decline in industrial output.

San Jacinto River - Tidal Subbasin

Industrial discharge in the San Jacinto River Tidal Basin is currently 1.818 million gallons per day. The BOD load is 53.83 pounds per day. Both are projected to increase through the year 1995 to a flow of 8.3 million gallons per day and BOD of 420 pounds per day.

Industrial discharge baseline standards are assumed to be Best Practicable Control Technology (BPCT) effective in 1977 and Best Available Control Technology (BAT) effective in 1984. The proposed Waste Treatment Management Plan must either affect the volume of discharge or change the discharge standard to incur direct costs or savings for industrial waste water treatment.

Non-Point Source Control

Although control practices are recommended by agencies with jurisdiction within the 208 Planning Area, nonpoint source pollution control is not required. Programs do exist at this time to encourage voluntary utilization of run-off control practices. Because of the absence of agencies engaging in control programs, the direct cost of non-point source control currently is limited to administration of voluntary programs and to financial incentives offered for compliance.

Table II-C-2

Current and Projected Industrial Discharge

Basin	1975 Flow MGD	1975 BOD lbs/day	1990 Flow MGD	1990 BOD lbs/day
Spring Creek	0	0	0	0
Cypress Creek	0.025	4.04	0	0
Lake Houston	0	0	0	0
Basin Subtotal	0.025	4.04	0	0
Clear Creek Nontidal	0	0	0	0
Clear Creek Tidal	0.4	14	0.7	22
Clear Lake	0	0	0	0
Armand Bayou	0	0	0	0
Dickinson Bayou-Nontidal	0	0	0	0
Dickinson Bayou-Tidal	0.086	7.370	0.2	9
Basin Subtotal	388.681	2107.11	0.9	31
Houston Ship Channel-upper	151.203	9797.59	-	-
lower	501.881	4159.03	-	-
Buffalo Bayou	1.923	65.72	-	-
Other Tributaries				
White Oak Bayou	1.639	51.940	-	-
Brays Bayou	2.249	124.48	-	-
Sims Bayou	10.116	3478.67	-	-
Vince Bayou	155.142	8955.39	-	-
Hunting Bayou	1.087	126.32	-	-
Greens and Halls Bayou	31.596	1127.57	-	-
Carpenter's Bayou	0.175	12.14	-	-
Basin Subtotal	857.011	27,899.85	717.2	20,779
San Jacinto -Tidal	1.818	53.83	8.3	420
Total	1247.535	30064.83	726.4	21,230

DISTRIBUTION OF DIRECT COSTS

Municipal

Municipal treatment plants are built and operated by a variety of public entities and authorities in the 208 Planning Area. Additional agencies monitor and regulate these plants. Through these public bodies municipal treatment costs are distributed to the public. Funds are raised via ad valorem taxes, user charges, legislative appropriation, and federal grants. The agencies operating municipal treatment plants in the 208 Planning Area are municipalities, chief amoung them the City of Houston, Water Districts, River Authorities and the Gulf Coast Waste Disposal Authority.

Cities have broad responsibilities to regulate activities affecting public health, safety, and welfare and to expend money for public services. Among these services, cities may construct and operate waste water treatment facilities or contract with other entities for provision of treatment. Areas surrounding a city and reserved for its future municipal growth are designated as areas of extraterritorial jurisdictions.Within its extraterritorial jurisdiction a city may regulate the planning of subdivisions and the formation of municipal utility districts. Cities may raise funds through ad valoreum taxes, user charges, and permit and license fees. Cities have the authority to issue general obligation bonds and revenue bonds to finance construction of waste water treatment facilities. Federal grants are available to fund planning, design, and construction of treatment facilities.

Water Districts are formed under general law or by special legislation as special-purpose districts for the provision of waste water treatment, water supply, drainage improvements, and, in some cases, recreation facilities. There are approximately 310 water districts in the 208 Planning Area. Ninety-five of these are special law districts formed by action of the Texas Legislature. There are 36 Water Control and Improvement Districts and 11 Fresh Water Supply Districts. Municipal Utility Districts, 168 in the Planning Area, are formed under Chapter 54 of the Texas Water Code which when passed in 1971 effectively supplanted the formation of special law districts. These districts vary in size from about 100 acres to more than 1200 acres. Most serve an area of approximately 300 acres, a single subdivision. Water Districts may issue municipal obligation bonds to finance sewer and water improvements, and levy ad valorem taxes and collect user fees to retire the debt and meet operation and maintenance expenses. Water Districts are subject to regulation by the Texas Department of Water Resources and by cities in whose extraterritorial jurisdiction the District may lie.

The San Jacinto River Authority (SJRA) has the power to own, operate, and maintain wastewater treatment facilities. River Authorities have the power to issue bonds supported by either ad valorem taxes or user charges. To date, the SJRA has relied upon revenue bonds rather than collection of ad valorem taxes. Unlike other entities operating wastewater treatment facilities, the jurisdiction of the SJRA extends throughout the watershed of the stream except those areas within the City of Houston.

The Gulf Coast Waste Disposal Authority (GCWDA) is a regional water pollution abatement authority with jurisdiction in Chambers, Harris, and Galveston Counties. The GCWDA has authority to issue general revenue bonds secured by ad valorem taxation, however, to date, GCDWA has relied upon revenue bonds. The Authority has provided a mechanism for funding construction of industrial waste treatment facilities through lower cost municipal obligations.

These entities, Cities, Water Districts, River Authorities, and the Gulf Coast Waste Disposal Authority are currently providing municipal wastewater treatment. General obligation bonds supported by ad valorem taxation are the prevalent means of funding capital costs for treatment facilities. Revenue bonds fund capital improvemetn in some instances and user charges are the principal source of operation and maintenance funds in most cases.

Public entities operate treatment facilities under the regulatory control of agencies at state and federal levels. The U.S. Environmental Protection Agency (EPA) establishes effluent standards governing treatment facilities and issues permits for plants. The agency administers water quality planning programs and issues grants for construction of treatment systems. The Texas Department of Water Resources was formed in 1977 through consolidation of the Texas Water Quality Board, Texas Water Development Board, and Texas Water Rights Commission. This new agency assumes the responsibility of establishing state water quality standards consistent with EPA standards, monitoring stream quality, and enforcing compliance with standards. The Texas Department of Water Resources coordinates the federal wastewater treatment construction grants program within the state.

Industrial

Direct costs of industrial waste treatment fall primarily upon the effluent producers. Public participation occurs through municipal treatment of industrial waste, through the activities of the Gulf Coast Waste Disposal Authority and through regulatory responsibilities of public agencies. Treatment costs absorbed by industrial dischargers are distributed to the public through higher product prices. Adequate data is not available to estimate the volume of industrial discharge to municipal treatment systems, and thus the cost of industrial treatment absorbed by municipal budgets may not be determined. As discussed previously, the Gulf Coast Waste Disposal

Authority offers a mechanism for funding industrial waste treatment facilities through public bonds. Lower interest rates for municipal obligations allow savings in total treatment costs which can be passed on to consumers. Costs of regulatory agencies are met by appropriations from federal, state, and local budgets. Fines levied against effluent standard violators are contributed to funds for operation of prosecuting agencies.

Non-Point Source Control

Although non-point sources presently are not regulated, programs are existing to encourage voluntary usage of run-off management. The Soil Conservation Service (SCS) of the U.S. Department of Agriculture primarily provides technical assistance and information regarding erosion control. The SCS does administer a voluntary watershed management program offering financial aid to participating farmers who use approved practices. Within the 208 Planning Area the Harris Soil and Water Conservation District works in conjunction with the SCS to promote voluntary erosion control. These efforts are aimed primarily at controlling agricultural run-off. Harris County participates in non-point source control through regulation of private sewage facilities. These agencies receive operating funds by appropriation.

The most ambitious public efforts to control non-point source pollution has been proposed by the Clear Creek Basin Authority. This program would regulate construction activity and would require submission to the Authority of storm water control, erosion control and sedimentation control plans in advance of land development within the basin. This program has been passed by the Authority's Board of Directors at this time although no funding sources exist for its implementation. The Authority does not have the power to levey taxes; it operates on proceeds from environmental litigation. The Authority does not have clearly designated power to establish and enforce non-point source controls, and enforcement of such controls may spawn litigation questioning the legality of the Authority's action.

INDIRECT COSTS

Wastewater treatment and non-point source pollution control will incur indirect costs as well as direct costs of construction, operation and maintenance, and administration. Indirect costs are the effects upon land value and upon employment incurred by the installation of treatment facilities and the enforcement of water quality policy. Information is not available to establish a baseline measure of land value within each basin and sub-basin. Consequently, only relationships that may determine changes in land value can be discussed. Generally, the availability of sewer service to land increases its developability and thus its value. Treatment costs imposed upon industry or restrictions placed upon construction may effect economic output with effects upon employment.

Land Value

Wastewater treatment issues affecting land value are the provison or refusal of service, relative increases in taxation, and the nuisance value of treatment facilities or polluted waters.

Subdivision regulations and building codes enforced by cities in the 208 Planning Area require assurance of sewer service or treatment provisions prior to approval of land development or building construction. New development must be within range of existing sewer service with adequate capacity or must provide such service. Outside of municipalities when the cost of conveying sewage to an existing system becomes comparable to construction of a new system, the new wastewater collection and treatment system is usually provided by formation of a Municipal Utility District. The existence of this mechanism allows the creation of a sewer system wherever a stream or channel furnishes a discharge point for a wastewater treatment plant. The expense of providing such an outfall point increases with distance from the stream. Outside of municipalities, the feasibility of land development, and consequent land value, increases in proximity either to existing sewage treatment capacity or to potential discharge locations.

Municipalities are responsible for providing sewage treatment within their limits. Creation of Municipal Utility District's within a municipality is possible,with the consent of the city. Because of the difficulty of obtaining such approval, Municipal Utility District formation is not generally available for provision of municipal services to developments within cities. Consequently, proximity to existing service supercedes proximity to outfall in the determination of the feasibility of development. If sufficient treatment or sewer capacity is not available to a site, development is effectively prohibited. Because of the inadequacy of sewage treatment and collection facilities in portions of the City, the City of Houston has imposed a limited moratorium restricting development to uses contributing less than 1500 gallons of effluent per acre per day. The moratorium restricts the type of development that may occur immediately and introduces holding costs into the feasibility of more intense forms of development.

Capital costs of municipal treatment facilities are usually funded by general obligation bonds secured by ad valorem taxation. Relative differences in facility costs, due either to varying process requirements or to non-regional versus regional treatment, are reflected in tax and assessment rates which in turn affect housing costs and business overhead. If treatment requirements mandated for different subbasins should require sufficient differences in taxation, then relative growth rates among subbasins could be affected.

Land values may be depressed in proximity to treatment facilities or polluted waters considered of nuisance value. The adverse affects of treatment plants upon adjacent uses varies according to the plant's type and efficiency of design, quality of operation, quantity of sewage treated, and climatological and topographical factors. In most instances, these effects are restricted to the immediate vicinity of the plant and must be evaluated by specific cases.

Polluted waters, because they are exposed to a greater land area, can have a greater affect upon land value. An EPA study, Benefit of Water Polluation Control on Property Values by David M. Dornbusch and Stephen M. Barrager, 1973, concluded that water quality improvement in badly polluted waters could increase residential property values by 3% to 25%. Beneficial effects could extend as much as 4000 feet from the water's edge. Benefits were detectable in cases where poor water quality had been subject to wide public awareness. The water quality criterion of greatest concern proved to be wildlife support capacity of the water. In the 208 Planning Area this issue is pertinent to the Lake Houston and Clear Lake Basins. Water quality conditions in neither of these basins have reached the grossly polluted conditions of of streams examined in the EPA study. Water Quality Management in the 208 Planning Area may deter property value losses rather than achieving increases.

The provision of wastewater treatment service, cost of service, placement of facilities, and maintenance of water quality are factors that may affect land value, either generating increases or provoking decreases. However, these are water quality related factors, among a much broader range of land value determinants. Accessibility and proximity are dominant factors affecting property values. Data is not available mapping land value within basins and subbasins. Rather than estimating total changes in land value, only the direction of relative change upon adoption of a selected plan may be evaluated.

Employment

Increases in production costs as a result of effluent restrictions and changes in production methods due to regulation could affect the economic output of the 208 Planning Area in turn affecting employment. Manufacturing industries will be most directly affected should changes be proposed in industrial wastewater regulations. Changes in output or employment within manufacturing industries would in turn affect employment in other sectors. The increase or decrease in output or employment within a specific industry affected by regulation would depend upon the processes and economics particular to each industry. However, gross effects of changes in policy may be estimated.

Employment projections for Harris County were presented in An Economic Base Analysis for the Gulf Coast State Planning Region, HGAC, 1974. Projected employment for 1995, listed in the accompanying table, is classified in nine sectors. Although the totals for the entire 208 Planning Area are larger, the projections are useful for the proportion of employment in each sector. The table also lists the percentage of each sectors production sold to purchasers outside the area.

The percentage of each industry's production sold as exports is provided as an indicator of the extent to which fluctuations within that industry will generate employment changes in other industries. An area's basic activity is defined as activity generating income from outside the area. Basic employment is defined as employment within basic industry. Economic base analysis is founded on the premise that non-basic employment is proportional to basic employment. Having accepted this premise, for a given change in activity within one industry the degree of effect on activity in all sectors may be determined by multiplying the area's proportion of total activity to basic activity by the percentage of production for export within that industry.

The HGAC economic base study for this area determined that approximately 55% of the area's employment is basic. This implies that the ratio of total jobs to basic industry jobs is approximately 1.82. Water quality management policies that affect employment in any sector will generate total employment repercussions roughly equal to the percentage of export production in that sector, times the 1.82 factor, times the employment change within that sector.

Table II-C-3

HARRIS COUNTY EMPLOYMENT FORECAST

Sector	Employment	% of Total	% Production for Export
Agriculture, Forestry, & Fisheries	2,535	(.2)%	65%
Mining	18,485	1%	66%
Construction	106,146	8%	23%
Manufacturing	239,384	19%	71%
Transportation, Communication, and Utilities	87,525	7%	40%
Wholesale and Retail Trade	289,882	23%	34%
Finance, Insurance, and Real Estate	70,199	6%	46%
Services	406,707	32%	43%
Public Administration	55,108	4%	93%
TOTAL	1,275,971	100%	55%

SUMMARY

The proposed Waste Treatment Management Plan will impose direct costs for water pollution control, require distribution of direct costs to the public, and generate indirect effects upon land value and employment. This chapter has presented available information to establish benchmarks from which to evaluate impacts of the proposed plan. The estimated baseline conditions assume compliance with existing state and federal standards.

Direct expenditures must be made for treatment of municipal wastewater, industrial effluent and non-point source pollution control. The estimated present worth cost of treating 1995 municipal wastelands at current permit levels is $481,900,000. This figure does include the cost of bringing existing treatment plants into compliance with current discharge standards set by the Texas Department of Water Resources. Estimates of current expenditures for industrial treatment are not available, but relative treatment costs may be inferred from projected flow and load within each sub-basin. Industry is assumed to comply with federal requirements of Best Practicable Control Technique by 1977 and Best Available Control Technique by 1984. Current costs of non-point source pollution control include only the cost of administration and financial incentives for voluntary run-off control programs.

Direct costs incurred for water quality control are distributed to the public via taxation, user charges, and product prices. Public entities operating municipal treatment systems finance capital costs with general obligation bonds secured by ad valorem taxes or by revenue bonds. User charges fund operation and maintenance costs. Industrial treatment costs absorbed by industry are reflected in increased product prices. Industrial treatment facilities may be funded by revenue bonds issued by public authority and supported by service contracts with industry. Programs for non-point source pollution control are supported by appropriation. Administration and enforcement costs are funded by user charges, appropriation, and litigation.

Water quality management policies may generate indirect effects upon land value and employment. Information is not available to prepare a measure of land value for each basin or sub-basin, however, relationships which determine how water quality decisions will increase or decrease land value have been examined. Employment for the area has been projected by H-GAC. Factors within each industry which will determine multiplier effects throughout other sectors have been presented. Should water quality decisions affect basic industry output, the affect upon employment in the Planning Area can be determined.

The description of baseline conditions provides a mark against which to measure impacts of proposed Water Quality Management policies. In addition to the description of conditions, the extent to which impacts may be determined has been indicated.

CHAPTER II-D
WATER

Introduction

A description of present day water quantity and quality conditions in the Greater Houston 208 planning area is contained in this chapter. The first section addresses the hydrology in the HGAC study area under critical flow conditions as defined by the Texas Department of Water Resources. The second section of the chapter is an analysis of existing water quality conditions in the study area. A physical description of the stream segments referenced in this chapter, along with listing of major point source dischargers, is presented in chapters 3, 4 and 5 of the Alternative Technical Subplans Report.

Baseline Hydrology

Critical stream flow conditions utilized in the analyses of alternative technical subplans as presented in the Alternative Technical Subplans Report are based on the two year, seven day low flow, i.e., the lowest flow expected to occur for seven consecutive days with a recurrence interval of two years. The two year, seven day low flow conditions for the stream segments of interest and their tributaries within the 208 study area are presented in Table II-6 of the Alternative Technical Subplans Report and are reproduced on the following page.

Baseline Water Quality

Introduction

The prime source of water quality information in the Houston-Galveston area is the Houston-Galveston Area Council Data Base. This document contains a compilation of all water quality data collected in the Houston-Galveston area, and known to the Houston-Galveston Area Council.

The water quality data base covers a time span from 1972 through 1975 with a few data points outside of this period. Data are recorded by stream segment in the HGAC Data Base, and the parameters included are flow, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total suspended solids, total coliform, fecal coliform, ammonia, nitrates, nitrites, and phosphates.

TABLE II-D-1

TWO-YEAR SEVEN-DAY LOW FLOWS AT HEADWATERS

Spring Creek	0.897 cfs
Willow Creek	0.482 cfs
Panther Creek	0.536 cfs
Brushy Creek	0.863 cfs
Walnut Creek	1.495 cfs
Mill Creek	1.402 cfs
Dry Creek	0.304 cfs
Runoff and Inflows	2.516 cfs
Cypress Creek	0.19 cfs
Lake Houston	65.52 cfs
Clear Creek - Nontidal	0.22 cfs
Hickory Slough	0.01 cfs
Mud Gulley	0.01 cfs
Turkey Creek	0.01 cfs
Mary's Creek	0.01 cfs
Clear Creek - Tidal	18.20 cfs
Clear Lake	22.36 cfs
Armand Bayou	0.51 cfs
Dickinson Bayou - Nontidal	0.1 cfs
Dickinson Bayou - Tidal	0.1 cfs
Houston Ship Channel[1]	
San Jacinto River - Tidal	0 cfs
White Oak Bayou	0.93 cfs
Buffalo Bayou	2.00 cfs
Brays Bayou	0.82 cfs
Sims Bayou	1.93 cfs
Vince Bayou	0.52 cfs
Hunting Bayou	0.92 cfs
Greens Bayou	1.12 cfs
Halls Bayou	0.89 cfs
Carpenters Bayou	0.01 cfs

[1] Headwater flow equal to Buffalo Bayou flow at the Turning Basin.

Further, the data are recorded by individual sampling locations within each segment. It is important to note, however, that many data points are missing with respect to either time, location, and/or constituent.

Because of the considerable volume of data included in the HGAC Data Base, a summary table has been prepared for each segment which presents constituent values averaged over the entire time frame of data points, along with the standard deviation of the recorded data and the extreme values reported for each parameter. The data also have been analyzed in a similar manner by year and by segment with the same information generated as explained above. The analysis by year is too voluminous to present in this report, but is available at the Houston-Galveston Area Council offices. Furthermore, graphical presentations of fecal coliform and dissolved oxygen concentrations by segment are presented in the Houston-Galveston Area Council Report titled, How Clean Do You Want Your Streams?

The baseline quality for each stream segment in the HGAC 208 area is presented in the following sections along with brief discussions of general water quality conditions and problems.

Spring Creek/Cypress Creek/Lake Houston Subbasin

Spring Creek - Segment 1008. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-2.

The dissolved oxygen is generally in compliance with state standards, but has been reported in violation numerous times in the period of record. Nutrient values have been reported in the HGAC Data Base which could be a potential cause of eutrophication. The mean levels of fecal coliform reported are in violation of stream standards.

Cypress Creek - Segment 1009. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-3.

This segment has had consistently acceptable levels of dissolved oxygen with few violations. However, the fecal coliform statistically is in violation of state water quality standards. The segment has a high eutrophication potential due to the raised levels of nitrogen and phosphorus which have been reported. The levels of solids and BOD are within acceptable levels.

Lake Houston - Segment 1002. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-4.

TABLE II-D-2

STATISTICAL ANALYSIS OF H-GAC
DATA BASE FOR SEGMENT 1008

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	75	85	72.79	157.24	906.00	0.00
DO	mg/l	144	16	6.72	2.17	13.20	0.83
BOD	mg/l	89	71	2.77	1.88	15.00	0.45
COD	mg/l	27	133	42.38	25.69	135.00	11.08
TSS	mg/l	140	20	83.64	118.64	966.00	2.00
Total Coliform mpn/100ml		99	61	468030.60	4121408.18	41000000.00	200.00
Fecal Coliform mpn/100ml		93	67	5387.88	24860.74	214000.00	0.00
NO_2N	mg/l	76	84	0.01	0.01	0.08	0.00
NO_3N	mg/l	134	26	0.55	0.78	4.60	0.00
NH_3N	mg/l	96	64	0.57	2.17	21.00	0.00
PO_4P	mg/l	114	46	1.34	8.06	86.00	0.00

TABLE II-D-3

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1009

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	5	107	61.28	111.57	260.00	1.60
DO	mg/1	111	1	7.90	1.72	13.40	4.00
BOD	mg/1	83	29	4.33	2.42	17.00	1.50
COD	mg/1	4	108	49.25	5.56	55.00	44.00
TSS	mg/1	96	16	208.93	310.76	2225.00	12.00
Total Coliform mpn/100ml		58	54	16855.51	45326.02	310000.00	0.00
Fecal Coliform mpn/100ml		56	56	4061.25	9107.57	43000.00	0.00
NO_2N	mg/1	18	94	0.06	0.11	0.40	0.00
NO_3N	mg/1	90	22	1.87	2.13	9.97	0.01
NH_3N	mg/1	52	60	1.02	1.22	5.00	0.00
PO_4P	mg/1	87	25	1.79	2.88	14.40	0.00

TABLE II-D-4

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1002

Data Item Name	Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow cfs	0	250	-	-	-	-
DO mg/1	238	12	7.93	1.71	23.00	3.70
BOD mg/1	215	35	2.90	1.44	8.60	0.20
COD mg/1	0	250	-	-	-	-
TSS mg/1	223	27	41.06	42.42	394.00	8.00
Total Coliform mpn/100ml	205	45	1608.36	2518.91	23000.00	0.00
Fecal Coliform mpn/100ml	185	65	165.02	437.63	3600.00	0.00
NO_2N mg/1	0	250	-	-	-	-
NO_3N mg/1	204	46	1.15	0.71	3.63	0.01
NH_3N mg/1	14	236	0.77	0.53	1.60	0.00
PO_4P mg/1	206	44	0.71	0.63	5.30	0.00

This segment has had consistently high water quality. The dissolved oxygen and fecal coliform numbers are statistically better than standards for most of the period of record. However, the levels of nutrients have historically been somewhat elevated. The total suspended solids concentration has remained low during the period of record in the HGAC Data Base.

Clear Lake/Clear Creek Subbasin

Clear Lake - Segment 2425. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-5.

The mean dissolved oxygen level in this segment is in compliance with state standards. The mean fecal coliform count is not in compliance with the state standards. The ammonia and phosphorus are elevated and may be a source of eutrophication.

Clear Creek Tidal - Segment 1101. A statistical analysis of the periods of record of the HGAC Data Base for the segment is shown in Table II-D-6.

The data in the HGAC Data Base indicates that this segment has a mean dissolved oxygen concentration which complies with the state water quality standards. The highest level of fecal coliform reported in the data base is also in compliance with the state water quality standards. The nutrient levels in the segment may pose a minor eutrophication problem.

Clear Creek Nontidal - Segment 1102. A statistical analysis of the period of record of the HGAC Data Base for the segment is in Table II-D-7.

The data available for this segment in the HGAC Data Base indicates that the mean dissolved oxygen level meets state standards. The fecal coliform levels, however, are generally in violation of state standards. The mean values of nitrogen and phosphorus pose a major eutrophication problem. The values of BOD and total suspended solids are acceptable.

Dickinson Bayou Tidal - Segment 1103. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-8.

The mean dissolved oxygen reported in this segment is in compliance with state standards; however, there are several violations of the dissolved oxygen standard in the record. The fecal coliforms are generally not in compliance with state standards for this segment. Nutrients in the segment are generally low with the exception of phosphorus, which could be a potential source of eutrophication.

TABLE II-D-5

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 2425

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	332	-	-	-	-
DO	mg/1	275	57	9.69	44.84	749.00	1.01
BOD	mg/1	173	159	4.73	2.08	16.00	0.16
COD	mg/1	66	266	41.44	10.38	81.70	21.40
TSS	mg/1	256	75	77.44	67.13	497.00	5.00
Total Coliform	mpn/100ml	65	267	7628.63	18465.55	80000.00	27.00
Fecal Coliform	mpn/100ml	63	269	1740.93	6761.09	53000.00	3.00
NO_2N	mg/1	198	134	0.00	0.01	0.08	0.00
NO_3N	mg/1	28	304	0.07	0.09	0.41	0.01
NH_3N	mg/1	27	305	0.59	0.52	1.50	0.00
PO_4P	mg/1	214	118	0.76	1.02	9.60	0.00

TABLE II-D-6

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1101

Data Item Name	Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow cfs	0	74	-	-	-	-
DO mg/1	68	6	6.80	2.39	12.00	1.55
BOD mg/1	31	43	4.81	2.09	9.40	1.80
COD mg/1	16	58	40.36	14.26	79.70	21.70
TSS mg/1	56	18	65.07	46.97	198.00	8.00
Total Coliform mpn/100ml	9	65	8711.11	8245.06	23000.00	600.00
Fecal Coliform mpn/100ml	9	65	401.11	374.44	1200.00	40.00
NO_2N mg/1	39	35	0.01	0.01	0.06	0.00
NO_3N mg/1	11	65	0.26	0.23	0.80	0.02
NH_3N mg/1	10	64	1.13	0.79	3.00	0.00
PO_4P mg/1	53	21	0.98	1.27	6.24	0.00

TABLE II-D-7

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1102

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	50	-	-	-	-
DO	mg/1	43	7	5.47	1.81	11.50	2.42
BOD	mg/1	23	27	2.80	1.51	6.50	1.00
COD	mg/1	11	39	31.31	17.95	81.70	16.60
TSS	mg/1	38	12	98.94	111.95	579.00	6.00
Total Coliform	mpn/100ml	16	34	63513.12	114538.56	460000.00	190.00
Fecal Coliform	mpn/100ml	16	34	5885.00	19526.31	79000.00	10.00
NO_2N	mg/1	20	30	0.04	0.03	0.12	0.00
NO_3N	mg/1	16	34	1.28	0.99	4.20	0.46
NH_3N	mg/1	17	33	1.98	2.55	11.00	0.00
PO_4P	mg/1	36	14	2.89	3.70	15.30	0.00

TABLE II-D-8

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1103

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	8	334	0.00	0.00	0.00	0.00
DO	mg/1	332	10	7.93	2.00	14.00	1.20
BOD	mg/1	68	274	4.41	2.64	15.00	1.00
COD	mg/1	9	333	38.86	20.16	65.80	23.00
TSS	mg/1	57	285	80.18	185.94	1420.00	10.00
Total Coliform mpn/100ml		278	64	17472.08	42384.52	240000.00	70.00
Fecal Coliform mpn/100ml		279	63	6467.03	26195.20	240000.00	10.00
NO_2N	mg/1	1	341	0.90		0.90	0.90
NO_3N	mg/1	33	309	0.08	0.13	0.63	0.00
NH_3N	mg/1	32	310	0.56	0.53	1.60	0.00
PO_4P	mg/1	52	290	1.75	1.98	13.50	0.00

Houston Ship Channel Subbasin

Turning Basin, Houston Ship Channel - Segment 1007. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-9.

This segment is frequently in violation of state water quality standards of dissolved oxygen and fecal coliform. The nutrient levels in this segment are generally high enough to be a potential cause of eutrophication.

Upper Houston Ship Channel - Segment 1006. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-10.

This segment is generally in compliance with the state water quality standards for dissolved oxygen although many violations are noted. The segment does not comply with state fecal coliform standards, and the nutrient loadings to this segment cause excessive levels of nutrients to exist. It should be noted again that this segment represents one of the world's largest concentration of industrial and municipal waste water dischargers.

Lower Houston Ship Channel - Segment 1005. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-11.

Tabbs Bay - Segment 2426. This segment which is a side bay of the Houston Ship Channel has acceptable dissolved oxygen and fecal coliform levels. However, the data in the HGAC Data Base indicates that this side bay has high levels of nitrogen and phosphorus which indicates a high eutrophication potential in the segment.

San Jacinto Bay - Segment 2427. This segment which is a side bay of the Houston Ship Channel has acceptable dissolved oxygen and fecal coliform levels. However, the data in the HGAC Data Base indicates that this side bay has high levels of nitrogen and phosphorus which indicates a high eutrophication potential in the segment.

Black Duck Bay - Segment 2428. This segment which is a side bay of the Houston Ship Channel has acceptable dissolved oxygen and fecal coliform levels. However, the data in the HGAC Data Base indicates that this side bay has high levels of nitrogen and phosphorus which indicates a high eutrophication potential in the segment.

Scott Bay - Segment 2429. This segment which is a side bay of the Houston Ship Channel has acceptable dissolved oxygen and fecal coliform levels. However, the data in the HGAC Data Base indicates

TABLE II-D-9

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1007

Data Item Name	Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow cfs	0	39	-	-	-	-
DO mg/1	38	1	1.91	2.35	7.70	0.00
BOD mg/1	39	0	10.38	5.20	23.00	3.00
COD mg/1	0	39	-	-	-	-
TSS mg/1	39	0	77.97	85.65	500.00	16.00
Total Coliform mpn/100ml	27	12	4511662.96	15437329.88	80000000.00	4500.00
Fecal Coliform mpn/100ml	26	13	61013.84	93733.58	350000.00	220.00
NO_2N mg/1	0	39	-	-	-	-
NO_3N mg/1	39	0	0.22	0.48	3.08	0.00
NH_3N mg/1	39	0	5.99	6.49	39.00	1.22
PO_4P mg/1	39	0	4.75	4.34	14.10	0.00

TABLE II-D-10

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1006

Data Item Name	Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow cfs	376	2444	317.17	1015.55	11000.00	0.20
DO mg/1	2709	111	4.82	3.55	82.00	0.00
BOD mg/1	2466	354	9.37	16.62	730.00	0.10
COD mg/1	390	2430	27.55	23.81	350.00	0.00
TSS mg/1	591	2229	113.69	170.12	1490.00	0.00
Total Coliform mpn/100ml	2439	381	1074852.90	6251898.34	170000000.00	1.00
Fecal Coliform mpn/100ml	2430	390	499005.21	4624544.29	160000000.00	0.00
NO_2N mg/1	804	2016	0.21	0.43	6.90	0.00
NO_3N mg/1	1067	1753	1.39	30.31	990.00	0.00
NH_3N mg/1	1098	1722	4.14	6.55	128.00	0.00
PO_4P mg/1	1105	1715	5.17	33.83	1119.00	0.00

TABLE II-D-11

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1005

Data Item Name	Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow cfs	0	75	=	-	-	-
DO mg/l	73	2	7.06	1.53	10.40	4.10
BOD mg/l	39	36	7.36	16.04	79.00	1.00
COD mg/l	0	75	-	-	-	-
TSS mg/l	75	0	93.56	431.59	3768.00	6.00
Total Coliform mpn/100ml	58	17	11555.31	49878.52	380000.00	30.00
Fecal Coliform mpn/100ml	56	19	107.50	160.84	700.00	10.00
NO_2N mg/l	0	75	-	-	-	-
NO_3N mg/l	75	0	0.19	0.15	1.04	0.03
NH_3N mg/l	75	0	1.44	1.51	11.10	0.00
PO_4P mg/l	75	0	2.61	2.44	10.60	0.00

TABLE II-D-12

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 2426

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	11	-	-	-	-
DO	mg/1	11	0	7.98	1.95	10.50	5.80
BOD	mg/1	6	5	8.00	7.53	22.00	3.00
COD	mg/1	0	11	-	-	-	-
TSS	mg/1	11	0	50.81	28.84	114.00	16.00
Total Coliform mpn/100ml		11	0	1468.63	1974.06	6300.00	10.00
Fecal Coliform mpn/100ml		10	1	43.00	77.61	260.00	10.00
NO_2N	mg/1	0	11	-	-	-	-
NO_3N	mg/1	11	0	0.36	0.68	2.40	0.01
NH_3N	mg/1	11	0	1.58	1.27	4.00	0.00
PO_4P	mg/1	11	0	3.18	3.03	10.10	0.00

TABLE II-D-13

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 2427

Data Item Name	Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow cfs	0	11	-	-	-	-
DO mg/l	11	0	7.80	1.42	10.60	5.70
BOD mg/l	6	5	6.83	4.87	14.00	1.00
COD mg/l	0	11	-	-	-	-
TSS mg/l	11	0	34.63	17.30	62.00	13.00
Total Coliform mpn/100ml	10	1	4076.20	7550.98	25000.00	10.00
Fecal Coliform mpn/100ml	9	2	42.22	78.38	250.00	10.00
NO_2N mg/l	0	11	-	-	-	-
NO_3N mg/l	11	0	0.19	0.11	0.50	0.06
NH_3N mg/l	11	0	1.70	0.84	3.00	0.20
PO_4P mg/l	11	0	3.11	2.76	7.80	0.00

TABLE II-D-14

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 2428

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	11	-	-	-	-
DO	mg/l	11	0	9.34	1.95	12.80	6.70
BOD	mg/l	6	5	10.50	8.66	28.00	5.00
COD	mg/l	0	11	-	-	-	-
TSS	mg/l	11	0	39.27	19.91	77.00	18.00
Total Coliform mpn/100ml		11	0	5361.81	7823.47	25000.00	20.00
Fecal Coliform mpn/100ml		10	1	102.00	116.79	290.00	10.00
NO_2N	mg/l	0	11	-	-	-	-
NO_3N	mg/l	11	0	0.13	0.13	0.38	0.01
NH_3N	mg/l	11	0	1.29	0.92	2.60	0.00
PO_4P	mg/l	11	0	2.64	2.21	5.80	0.00

TABLE II-D-15

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 2429

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	11	-	-	-	-
DO	mg/1	11	0	7.54	1.90	11.70	5.40
BOD	mg/1	5	6	8.80	6.90	20.00	4.00
COD	mg/1	0	11	-	-	-	-
TSS	mg/1	10	1	37.00	20.19	72.00	10.00
Total Coliform mpn/100ml		11	0	6618.18	10633.98	37000.00	100.00
Fecal Coliform mpn/100ml		10	1	81.00	89.49	260.00	10.00
NO_2N	mg/1	0	11	-	-	-	-
NO_3N	mg/1	10	1	13.80	42.93	136.00	0.05
NH_3N	mg/1	11	0	1.70	1.15	3.70	0.20
PO_4P	mg/1	11	0	3.25	2.82	8.40	0.00

that this side bay has high levels of nitrogen and phosphorus which indicates a high eutrophication potential in the segment.

Burnett Bay - Segment 2430. This segment which is a side bay of the Houston Ship Channel has acceptable dissolved oxygen and fecal coliform levels. However, the data in the HGAC Data Base indicates that this side bay has high levels of nitrogen and phosphorus which indicates a high eutrophication potential in the segment.

San Jacinto River Tidal - Segment 1001. A statistical analysis of the period of record of the HGAC Data Base for the segment is shown in Table II-D-12.

This segment has historically shown high levels of total suspended solids and high coliform counts. The segment also has typically had high levels of phosphorus and nitrogen and could be considered as having a high eutrophication potential. The dissolved oxygen has maintained a very acceptable level throughout the period of record of the data base.

Other Water Bodies With No Baseline Information Available

The following bodies of water in the Greater Houston Area were not addressed in this chapter because no information was available either in How Clean Do You Want Your Streams? or the HGAC Data Base.

Clear Lake Subbasin

1) Armand Bayou
2) Dickinson Bayou

Houston Ship Channel Subbasin

1) Brays Bayou
2) Buffalo Bayou
3) Sims Bayou
4) Hunting Bayou
5) Vince Bayou
6) Greens/Halls Bayou
7) Carpenter Bayou
8) White Oak Bayou

Future Water Quality Without the 208 Plan

In order to properly assess the impact of the proposed 208 plan on water quality in the study area, it is also necessary to investigate future water quality conditions without implementation of the

TABLE II-D-16

STATISTICAL ANALYSIS OF H-GAC
DATA BASE FOR SEGMENT 2430

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	11	-	-	-	-
DO	mg/1	11	0	8.89	2.06	12.00	6.50
BOD	mg/1	7	4	7.42	4.68	16.00	3.00
COD	mg/1	0	11	-	-	-	-
TSS	mg/1	11	0	30.18	11.03	51.00	13.00
Total Coliform	mpn/100ml	11	0	1858.18	2147.83	6400.00	30.00
Fecal Coliform	mpn/100ml	10	1	73.00	103.49	330.00	10.00
NO_2N	mg/1	0	11	-	-	-	-
NO_3N	mg/1	11	0	0.18	0.16	0.60	0.01
NH_3N	mg/1	11	0	1.61	0.93	3.00	0.20
PO_4P	mg/1	11	0	3.34	2.77	7.74	0.00

TABLE II-D-17

STATISTICAL ANALYSIS OF H-GAC DATA BASE FOR SEGMENT 1001

Data Item Name		Valid Observations	Missing Observations	Average	Standard Deviation	High	Low
Flow	cfs	0	60	-	-	-	-
DO	mg/1	60	0	8.08	1.69	11.50	5.00
BOD	mg/1	16	44	3.36	2.47	10.00	1.00
COD	mg/1	0	60	-	-	-	-
TSS	mg/1	30	30	48.76	61.16	330.00	0.00
Total Coliform	mpn/100ml	23	37	22322.30	95529.01	460000.00	80.00
Fecal Coliform	mpn/100ml	23	37	20405.82	95831.01	460000.00	2.00
NO_2N	mg/1	0	60	-	-	-	-
NO_3N	mg/1	30	30	0.14	0.15	0.80	0.00
NH_3N	mg/1	30	30	0.52	0.80	3.60	0.00
PO_4P	mg/1	30	30	2.32	2.14	7.22	0.21

preferred technical subplans. This topic is discussed in detail for both the wet weather and dry weather cases in the HGAC Alternative Technical Subplans Report.

The projected water quality in each stream segment without implementation of the preferred plan is defined as Level 1 in the methodology section of the Alternative Technical Subplans Report. In those segments, where the preferred plan recommends Level 1 treatment, the future water quality level without the plan is by definition the same water quality level as will be obtained by implementation of the preferred plan. In these cases, Level 1 treatment will result in Level 3 water quality which is considered fishable/swimmable water quality as defined in the methodology section of the Alternative Technical Subplans Report.

CHAPTER II-E
AIR

Introduction

An understanding of the meteorology and climatology of the Houston-Galveston area facilitates the consideration of the ambient air quality of the region. The winds in the area affect both the ability of the atmosphere to disperse airborne pollutants as well as the direction and distance that the pollutants are transported. In addition to wind data, other climatological data, especially precipitation data, can be useful when considering the effects of plan implementation on other disciplines.

An example would be the consideration of the effects of flooding and wastewater overflows on water quality and aquatic biology.

Current Meteorological Conditions

The Houston-Galveston area has a predominantly marine climate. The prevailing winds in the region are from the southeast and south, except during January, when frequent continental polar cold frontal passages result in prevailing northerly winds. The Gulf of Mexico exerts a significant influence on the climate of the region by moderating temperatures during both the summer and the winter, by providing the moisture for abundant precipitation throughout the year, and by affecting low-level winds, especially during the late spring and summer when the sea breeze influences may extend inland as far as 50 miles.

Temperatures

The annual average temperature in the Houston-Galveston area ranges from 68°F in northern portions of the study area to 69.8°F in the southern portions. January is the coolest month, while July and August are the warmest months of the year.

Precipitation

Annual average precipitation ranges from 42 inches to 48 inches throughout the region. Precipitation is plentiful throughout the year, with March normally being the driest month and May, June and September being the wettest months. Snow is rare in this region, but on February 14-15, 1895, up to 20 inches of unmelted snow were measured. In only one winter season, 1972-73, were there as many as three measureable snows recorded.

Relative Humidity and Evaporation

The average annual relative humidity in the Houston-Galveston area is about 78 percent, with the late summer months being the most humid for inland regions and the winter and spring months being the most humid in the Galveston Bay area. June is one of the least humid months inland, while October is one of the least humid months in the Galveston Bay area. The mean annual lake evaporation is 53 inches and the mean annual evaporation excess (evaporation-rainfall) for the region is 6 to 8 inches.

Winds and Dispersion

Winds are generally from the south and south-southeast in the Houston-Galveston area. The monthly average winds are strongest during March and April and are lightest during August. The sea breeze often provides east through south winds during the afternoon hours during the spring and summer months. Because of the light winds, stagnating surface anticyclones, and upper-level ridging that often persist during the late summer and early fall in southeastern Texas, poor air dispersion conditions are occasionally a problem in this region during that period.

Approximately five Air Stagnation Advisories are issued for southeastern Texas, including the Houston-Galveston area, during a typical year. The advisories are issued when the combination of low mixing depths and light winds restricts ventilation in the area. However, this number of Air Stagnation Advisories is not excessive when compared to many portions of the eastern and western United States, which experience a much greater frequency of occurrence of poor dispersion conditions. On an annual basis, the Houston area experiences inversions and/or isothermal layers (based below 500 feet) 25 percent of the time.

Cloud Cover

The Houston-Galveston area receives approximately 60 percent of the possible sunshine during a normal year, with opaque cloud cover averaging 6.1 out of 10 during the sunrise to sunset period. The area has 94 clear days, 109 partly cloudy days, and 162 cloudy days during a typical year. Measurable precipitation falls on about 100 days during the year, with thunderstorms occurring on 69 of these days. Thunderstorms are most common during the summer and least common during the winter. Heavy fog, which reduces the visibility to one-quarter of a mile or less, occurs on about 40 days of the year, on the average.

Extreme Phenomena

Severe local storms (i.e., tornadoes, windstorms, and hailstorms) are fairly common in the Houston-Galveston area during the spring and summer months, but are not as damaging or intense as the severe local storms which occur in the northern portions of Texas. For instance, many of the tornadoes in the Houston-Galveston area are small and weak, created by the same dynamics that cause waterspouts. Moreover, the hailstorms that affect the region seldom cause the destruction or the large hailstones that are found in the Great Plains.

On an annual basis, Harris County has one tornado per 1,000 square miles. However, this annual tornado density increases to two tornadoes per 1,000 square miles in the Galveston Bay area.

Approximately one windstorm occurs during a normal year in Harris County (excluding tropical cyclones), per 1,000-square mile area. The windstorm density increases to 1-1/2 per 1,000-square miles in the Galveston Bay area. Finally, on an annual basis, less than one hailstorm occurs per 1,000 square miles in the Houston-Galveston area.

Of more importance than severe local storms in the Houston-Galveston area are tropical storms, hurricanes and great hurricanes*, which have caused considerable destruction in the region in the past. The 50-mile segment of coastline which includes Harris, Galveston, and Chambers Counties was affected by tropical storms more often than any other such 50-mile segment along the Texas coastline during the 84-year period from 1886 through 1970. Specifically, during any given year, there is a 20 percent probability that a tropical storm will achieve landfall in the Houston-Galveston segment and there are 12 percent and 4 percent probabilities that a hurricane or great hurricane will come ashore in that region, respectively.

In association with the frequent landfall of tropical storms in the region, the Houston-Galveston area experiences the highest extreme-mile winds (sustained for one minute at 30 feet above ground) in the state for all recurrence intervals. Table II-E-1 lists the ranges of extreme-mile winds in the study region for various recurrence intervals.

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*Tropical cyclones (winds of 40 miles per hour or higher)
Hurricanes (winds of 74 miles per hour or higher)
Great hurricanes (winds of 125 miles per hour or higher)

Heavy rains occur frequently in the Houston-Galveston area, often causing severe flooding. Table II-E-2 summarizes the maximum rainfalls that can be expected in the Houston-Galveston area during various short-term periods, as a function of several long-term recurrence intervals.

TABLE II-E-1

EXTREME-MILE WINDS

	Years				
Mean Recurrence Interval	2	10	25	50	100
Wind Speed (miles/hour)	50	60-65	70-75	80-90	90-100

TABLE II-E-2

RAINFALL TOTALS FOR VARIOUS RECURRENCE INTERVALS

Duration of rainfall	Rainfall in inches for Recurrence interval of 100 years
30 minutes	3.5
1 hour	4.5
2 hour	6
3 hour	6.5
6 hour	8.5
12 hour	10.5
24 hour	12

Current Air Quality Conditions

Introduction

In comparison with other regions of the United States, the general meteorological potential for the dispersal of air pollutants is fairly good in the Houston-Galveston area. Only during the summer and early fall months does the dispersion potential, or ventilation, deteriorate for extended periods (over 36 consecutive hours). During these periods the meteorological potential exists to cause an air pollution episode and the violation of air quality standards. Periods of poor dispersion potential occur about five times a year in the Houston-Galveston area and Air Stagnation Advisories are issued during these periods. However, the rapidly growing nature of the Houston-Galveston area has resulted in a constantly increasing volume of emissions of air pollutants, both by the industrial and the residential sectors. As a result, the ability of the atmosphere to dilute the emissions and to achieve acceptable air quality levels is steadily decreasing throughout the study area. Therefore, projected developments must consider their ramifications on the ambient air quality.

Most of the data on gaseous air pollutants (i.e., not particulates) presented in this discussion were obtained from the four monitoring stations operated in the Houston area by the Texas Air Control Board (TACB). The TACB stations monitor all of the important air pollutants and generally provide high quality data. Two of the stations (Station 1, in east Houston, and Station 2, in Aldine) are in the immediate Houston area, while the other two stations (Station 3 in Texas City and Station 4 in Clute) are south of the City of Houston. These two southern stations are normally upwind of Houston and provide important data relating to the transportation of pollutants in the Houston-Galveston area. Data from all four of these stations is necessary because of the regional nature of the air pollution problem in the Houston-Galveston area.

Additional ambient air quality data were obtained from numerous monitoring locations maintained by the City of Houston. These data, while not always as accurate as the information from the Texas Air Control Board, nevertheless provided important information on the ambient air quality in portions of Houston where TACB monitors were absent. Pollution concentration contours are presented later in this section and are constructed primarily from air quality data collected by the City of Houston.

Background Information on Various Air Pollutants

Total suspended particulates, or TSP, (e.g., dust, smoke, and various fumes) have several effects on the environment. In addition to reducing the visibility and contributing to a "dirty" quality of the air, small particulates may also be inhaled deep into the lungs. When harmful chemicals are constituents of these small particulates, lung damage may result when the exposure is prolonged. Particulates can also assume the role of a catalyst, accelerating chemical reactions such as the transformation of sulfur dioxide to sufuric acid or to sulfate compounds. From a meteorological standpoint, small particulates may act as condensation nuclei for the formation of water droplets, thereby prolonging rain, mist, and fog (a negative effect). High volume sampler (hi-vols) are used to collect TSP samples on filters, which are then weighed to measure the quantity of TSP. The sulfate and nitrate content of these samples are then determined using chemical methods.

Although sulfates and nitrates are the end products of other pollutants and are, therefore, indicators of the concentrations of these pollutants, they can be significant in their own right. Sulfates can adversely affect the health of the general public by aggravating existing respiratory illnesses, by contributing to increases in the incidence of respiratory illnesses, and by increasing the death rate when significantly high concentrations prevail over an extended period of time. Sulfates are generated both by natural means and anthropogenically (made by man).

Various gaseous pollutants are often present in the ambient air. Oxidants, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), hydrocarbons, and hydrogen sulfide (H_2S) are some of the gaseous compounds which are commonly monitored.

Oxidants are a primary ingredient of photochemical smog. Ozone (O_3) is a principal oxidant that can be monitored readily. In significantly high concentrations, ozone can cause headaches, coughing, fatigue, damage to plants, and the deterioration of materials. Ozone is formed and dissipated by complex photochemical reactions involving hydrocarbons, oxides of nitrogen, and sunlight.

Nitrogen dioxide (NO_2) is yellowish-brown in color. This pollutant reduces visibility because of its color, in addition to promoting photochemical reactions which produce smog. NO_2 may also combine with other substances to form particulates or aerosols, which may then cause visibility to deteriorate further. Nitrogen dioxide can damage vegetation and can form nitric acid by combining with water vapor. Finally, NO_2 can harm the lungs with prolonged exposure, even if the ambient concentrations are fairly low (below 0.05 ppm or 100 micrograms per cubic meter).

Carbon monoxide is caused by a process involving incomplete combustion and is generally produced by automobiles. This pollutant can cause headaches, nausea, fatigue, and in high concentrations, death.

Hydrocarbons are released by a number of sources, including industry and automobiles. In addition to their own effects on health, hydrocarbons also are the primary source of photochemical oxidants, which are produced when sunlight reacts with the hydrocarbons. Hydrocarbons generally are separated into three categories: methane (which is generally naturally-occurring), non-methane hydrocarbons (some of which, such as pollens from trees, are also naturally-occurring) and total hydrocarbons. Monitoring techniques for hydrocarbons are generally unreliable, so that both absolute and comparative ambient measurements should be viewed with some reservations.

Sulfur dioxide (SO_2) generally results from the burning of sulfur-containing fossil fuels, from the refining of petroleum and from non-ferrous smelters. Sulfur dioxide, at sufficiently high levels, irritates the upper respiratory tract and damages plants. At lower concentrations, when transported by particulates, it harms lung tissue. Sulfur dioxide is also the major constituent necessary for the formation of sulfates and sulfuric acid.

Hydrogen sulfide (H_2S) is a gas which has the unpleasant odor of rotten eggs. In low concentrations, it can tarnish silver and copper. In high concentrations, hydrogen sulfide is hazardous to health and can cause death.

Ambient Air Quality Standards

The national primary and secondary ambient air quality standards are presented in Table II-E-3 for reference purposes. The primary standards denote the levels of air quality necessary to protect the public health and the secondary standards represent the level of air quality needed to protect the public welfare from known or anticipated adverse effects from pollutants in the ambient air. The ambient air is the prevailing outdoor air, which can also be referred to as "the community air." The Environmental Protection Agency (EPA) defines the ambient air as "that portion of the atmosphere external to buildings, to which the general public has access."

The Texas air quality standards are essentially the same as the federal primary and secondary air quality standards. The only significant additional state standard is the 30-minute average sulfur dioxide standard, which is measured primarily along property lines. This standard is 0.4 ppm for a 30-minute averaging period, except in Harris, Chambers, and Galveston Counties, where the standard is

TABLE II-E-3

FEDERAL AMBIENT AIR QUALITY STANDARDS

National Standards	Primary[1]	Secondary[2]
Carbon Monoxide (CO)	35 ppm hourly average, not to be exceeded more than once a year	Same as primary
	9 ppm eight-hour average, not to be exceeded more than once a year	Same as primary
Nitrogen Dioxide (NO_2)	0.05 ppm annual average	Same as primary
	100 micrograms/m^3 annual average	
Non-methane Hydrocarbons[3]	0.24 ppm 6-9 a.m. average, not to be exceeded more than once a year	Same as primary
Photochemical Oxidants	0.08 ppm hourly average, not to be exceeded more than once a year	Same as primary
Total Suspended Particulate Matter[3]	260 micrograms/m^3 24-hour average, not to be exceeded more than once a year	150 micrograms/m^3 24-hour average, not to be exceeded more than once a year
	75 micrograms/m^3 annual geometric mean	60 micrograms/m^3 annual geometric mean
Sulfur Dioxide (SO_2)	365 micrograms/m^3 (0.14 ppm)	1300 micrograms/m^3 (0.5 ppm) 3-hour average, not to be exceeded more than once a year
	80 micrograms/m^3 (0.03 ppm) annual average	

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[1] Primary standards define levels of air quality which the U.S. Environmental Protection Agency's (EPA) Administrator judges necessary to protect the public health with an adequate margin of safety.

[2] Secondary standards define levels of air quality which the EPA Administrator judges necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[3] These are for use as guides in achieving other standards. The non-methane hydrocarbon level relates to the oxidant standard; the 60 micrograms/m^3 geometric mean relates to the 24-hour standard for particulates.

ppm = parts per million

0.28 ppm for a 30-minute averaging time. This standard is 0.28 ppm in those three counties because of the numerous sulfur dioxide sources and the resultant danger of violations of sulfur dioxide regulations.

Sources of Pollutant Data

The majority of the air quality data presented in this report were collected at four Texas Air Control Board monitoring locations. Additional monitoring data, mostly particulate data, were collected by the City of Houston, Environmental Division.

Although the air quality levels presented in this assessment in general are representative of the ambient air in the Houston-Galveston region, sampling locations can be influenced significantly by nearby activity. Construction is a common pollution source which can affect pollutant levels, especially those of particulates. Data which the Texas Air Control Board has denoted as being influenced appreciably by activity such as construction have been deleted from the characterization of background conditions.

Continuous Ambient Air Quality Monitoring of Gaseous Pollutants

Ambient air quality monitoring data from the Continuous Air Monitoring (CAMS) network of the Texas Air Control Board have been assimilated as shown on Table II-E-4 to provide a characterization of the ambient air quality of the Houston-Galveston area. These data were collected at strategic locations in Air Quality Control Region (AQCR) No. 7 and probably represent a non-biased representation of the existing ambient pollutant concentrations in the sub-basins under investigation. The data are for 1976 and the winter, spring, and summer quarters of 1977. (The fall quarterly summary for 1977 had not yet been released for distribution by the TACB when this report was prepared.) Data for several pertinent averaging times are presented in several tables, one of which compares air quality data with ambient standards. The monitoring stations which were used are located as follows:

Station Number	Station Location
1	East Houston: 1224 Mae Drive
2	Aldine: Hambrick Junior High School 4600 Aldine Mail Route Road
3	Texas City: 2702 13th Avenue North
4	Clute: Commerce Street at Cobb Field

TABLE II-E-4

PRIMARY POLLUTANTS

	(ppm) Ozone 2nd highest hr.	Ozone percent of time >0.08 ppm	(ppm) Carbon Monoxide 2nd highest hr.	(ppm) Carbon Monoxide 2nd highest 8 hr.	(ppm) Nonmethane hydrocarbons 6-9 a.m. high	(ppm) Sulfur Dioxide 2nd highest 24 hr.	(ppm) Sulfur Dioxide annual mean	(ppm) Sulfur Dioxide 2nd highest 3 hr.	(ppm) Nitrogen Dioxide annual mean
Maximum allowable by ambient air standards (parts per million)	0.080	0.0 %	35	9	0.24	0.14	0.03	0.50	0.05
Period									
				STATION 1					
1976	0.267	4.2	8.6	6.7	3.4	0.01	0.00	0.07	0.02
1st qtr., 1977	0.106	0.7	12.5	6.4	2.8	0.01	-	0.06	-
2nd qtr. 1977	0.220	6.3	8.1	5.4	6.1	0.00	-	0.02	-
3rd qtr. 1977	0.167	4.5	4.8	3.2	5.1	0.00	-	0.01	-
				STATION 2					
1976	0.255	7.7	7.9	6.2	3.9	0.00	0.00	0.00	0.00
1st qtr., 1977	0.098	0.4	3.1	2.2	3.3	0.00	-	0.00	-
2nd qtr., 1977	0.261	11.1	4.8	4.4	2.4	0.00	-	0.00	-
3rd qtr., 1977	0.193	5.0	5.3	2.8	2.2	0.00	-	0.00	-
				STATION 3					
1976	0.203	5.1	5.5	2.6	3.8	0.01	0.00	0.21	0.01
1st qtr., 1977	0.073	0.1	0.9	0.3	0.7	0.00	-	0.02	-
2nd qtr., 1977	0.202	7.8	4.7	1.1	2.1	0.00	-	0.00	-
3rd qtr., 1977	0.197	1.3	1.9	0.8	2.9	0.00	-	0.00	-
				STATION 4					
1976	0.186	4.0	5.2	2.3	4.5	0.00	0.00	0.03	0.01
1st qtr., 1977	0.104	1.8	5.2	2.7	3.6	0.00	-	0.01	-
2nd qtr., 1977	0.176	4.2	2.9	1.8	2.1	0.00	-	0.00	-
3rd qtr., 1977	0.101	0.6	2.5	0.9	6.4	0.00	-	0.00	-

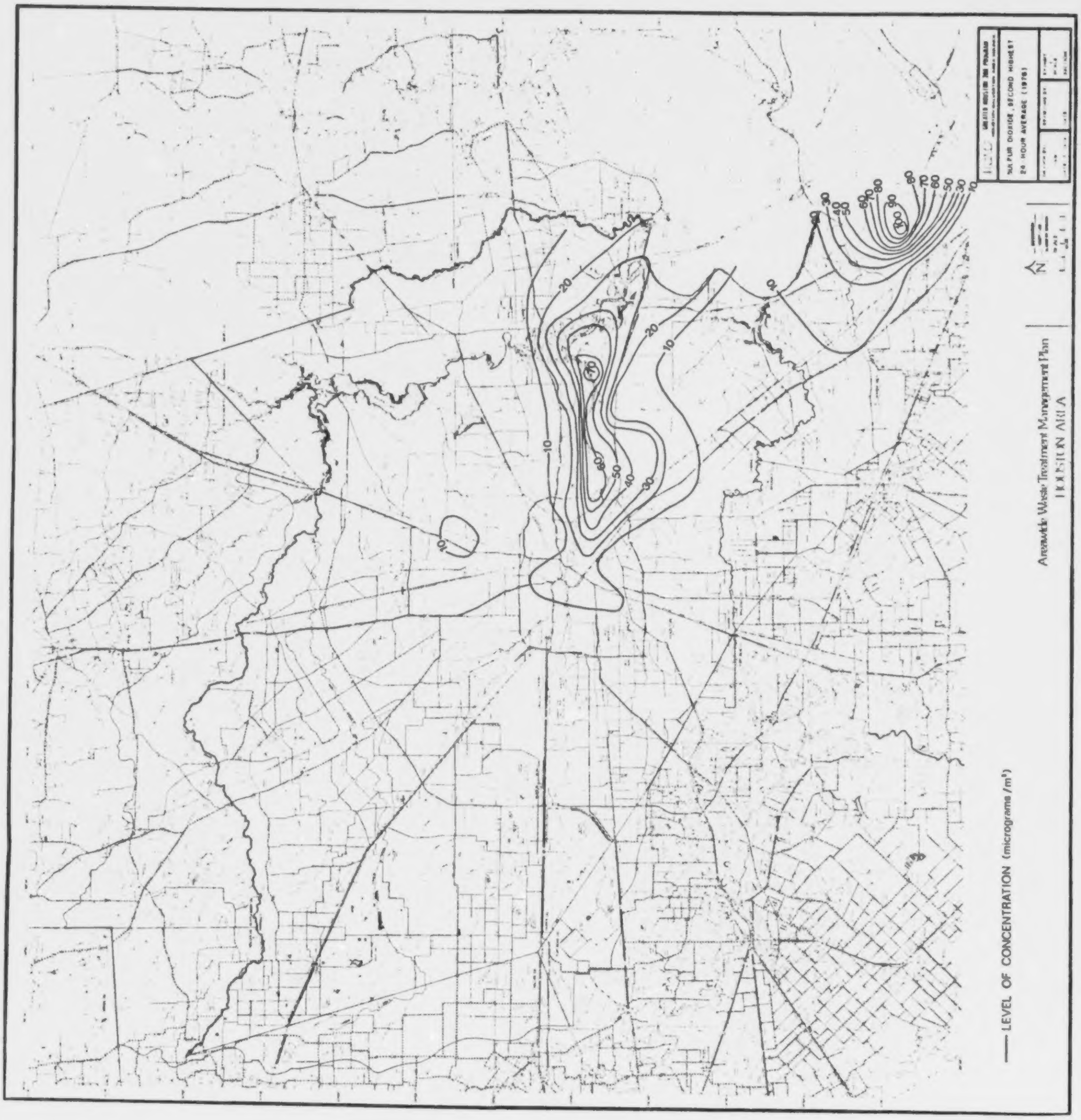
The most recent continuous air quality monitoring data (gaseous pollutants) from the Texas Air Control Board's CAMS network of monitoring vans indicate that the Houston-Galveston area does not currently comply with federal and state regulations for two gaseous pollutants: (1) photochemical oxidants (ozone); and (2) nonmethane hydrocarbons during the 6 to 9 a.m. period. The region is currently in compliance with air quality standards for carbon monoxide, sulfur dioxide, and nitrogen dioxide.

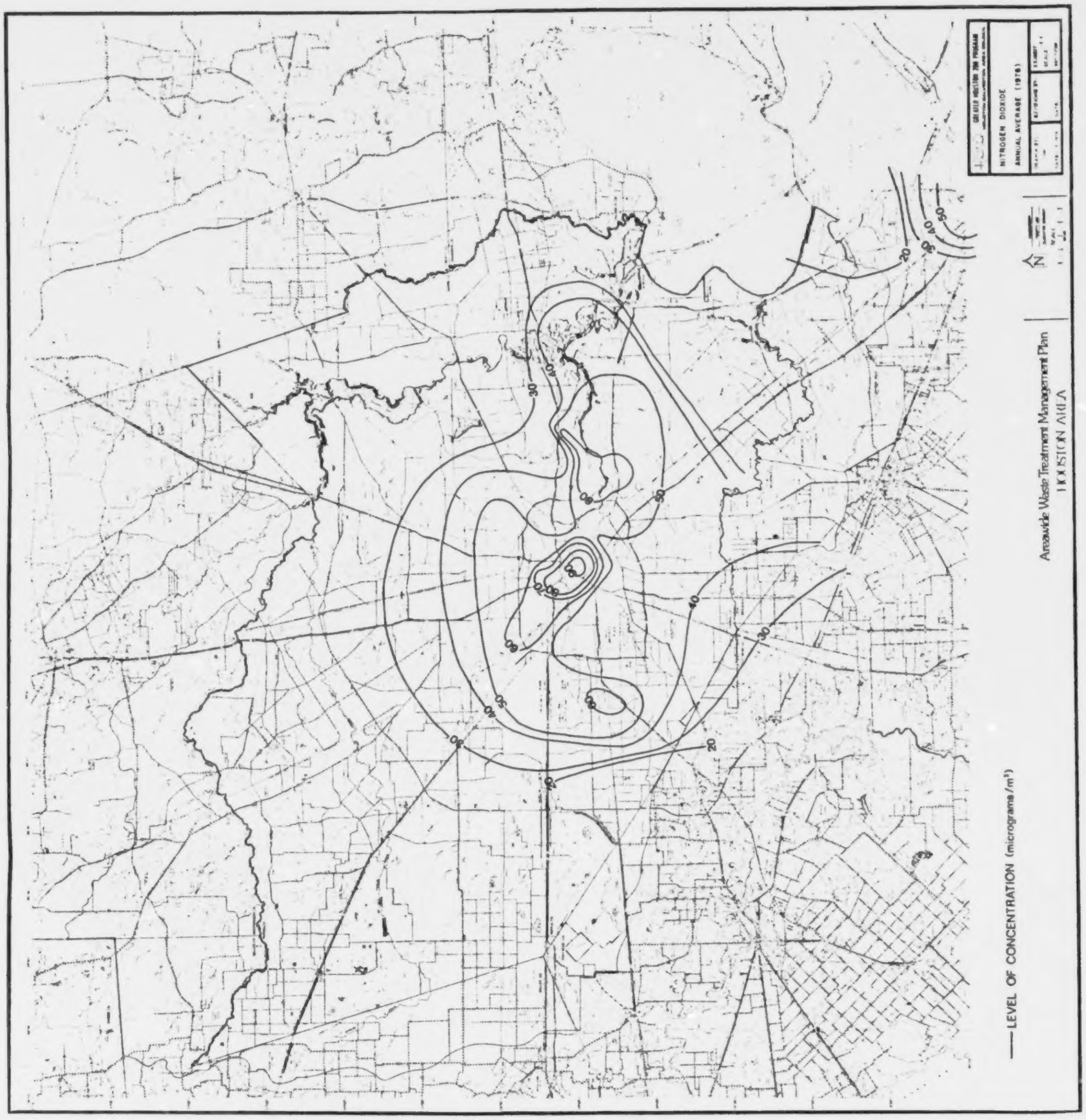
Comparisons of these ambient air quality data with data from other cities in Texas indicate that, overall, the Houston area has one of the poorest ambient air quality ratings in Texas. Only the El Paso area, where smelting operations and topography combine to create a significant air quality problem, has a comparably high level of pollutants in its air. These high concentrations occur both on the short term (hourly and daily averages) and on an annual average basis.

The Houston-Galveston area generally had the highest hourly average ozone readings in the state as well as the highest percentage of excursions of the ozone standard during 1976 and the first three quarters of 1977. Stations 1, 2, and 3 had higher ozone levels than Station 4, which is well south (and normally upwind) of Houston. Stations 1 and 2 had relatively high carbon monoxide levels in comparison to other locations in Texas. Stations 3 and 4 had relatively low levels of CO. All four stations reported relatively high levels of non-methane hydrocarbons during the 6 to 9 a.m. period during 1976 and 1977. Only stations 1 and 3 reported sulfur dioxide levels of any consequence, and these concentrations were well within the national standards and about average in comparison to other monitoring results from throughout the state.

Isopleths (lines of equal concentration) of the second highest 24-hour averages of sulfur dioxide measured at monitoring stations throughout the Houston-Galveston area are presented in Figure II-E-1. The greatest concentrations occurred in Texas City and along the Ship Channel. These concentrations occurred in Texas City and along the Ship Channel. These concentrations are well below the federal primary standard of 365 micrograms/meter^3 for a 24-hour period.

The annual average isopleths for nitrogen dioxide during 1976 are shown in Figure II-E-2. The concentrations are all below the federal primary and secondary standards of 100 micrograms/meter^3 for the annual average; however, a site in the center of Houston had an annual average of 96 micrograms/meter^3, which is relatively high. The distribution of nitrogen dioxide in the Houston-Galveston area is a function of the volume of traffic as well as industrial emissions. Therefore, the distribution is centered in downtown


GREATER HOUSTON 208 PROGRAM
SULFUR DIOXIDE, SECOND HIGHEST
24 HOUR AVERAGE (1978)
Areawide Waste Treatment Management Plan
HOUSTON AREA
N
— LEVEL OF CONCENTRATION (micrograms/m³)
10
20
30
40
50
60
70
80
90
100


GREATER HOUSTON 208 PROGRAM
NITROGEN DIOXIDE
ANNUAL AVERAGE (1976)
N
Areawide Waste Treatment Management Plan
HOUSTON AREA
— LEVEL OF CONCENTRATION (micrograms/m³)
20
30
40
50
60
70
80
90

Houston with other maxima along the Ship Channel in Galena Park and Pasadena, in southwestern Houston, and in northwestern Houston. The isopleths closely parallel Interstate 610 in the northern portions of Houston.

Monitoring data are also available for several pollutants for which federal and/or state standards and regulations are not currently enforced. These additional substances are total hydrocarbons, methane, hydrogen sulfide, total sulfur (sulfur dioxide and hydrogen sulfide), nitric oxide (NO), and oxides of nitrogen (NO_X). These pollutants, if present in sufficiently high concentrations, do have an effect on health and vegetation. In addition, national and/or state regulations on these pollutants may be enforced at some future time, so these data are pertinent to a discussion of the existing or baseline air quality in the Houston-Galveston area. Table II-E-5 lists the concentrations of these substances for various averaging times during 1976 and also during each of the first three quarters of 1977. Again, standards are not currently being promulgated for these substances.

On a statewide basis, Station 1, in east Houston, reported the highest levels for all pollutants and averaging times considered in Table II-E-5. Station 2 had slightly lower levels during the 1976-1977 monitoring period, but the concentrations were nevertheless higher than most of the concentrations reported from other Texas monitoring locations. Station 3 reported relatively high levels of total hydrocarbons, methane, total sulfur (1-hour) in 1976, and 24-hour nitric oxide. Station 4 experienced relatively high levels of total hydrocarbons, nitric oxide (NO), and oxides of nitrogen (NO_X).

Non-continuous Monitoring of Ambient Air Quality

At this time, comprehensive data on total suspended particulates (TSP) are available for the Houston-Galveston area for 1976 only. The data, which were collected by both the Texas Air Control Board and the City of Houston, were monitored non-continuously. That is, the high-volume samplers which monitored particulates were run continuously over 24-hour periods, but were not run every day. Federal regulations require that particulates be sampled only on every sixth day. Particulate, sulfate and nitrate levels are all measured in micrograms per cubic meter instead of parts per million (ppm). Data are presented in Table II-E-6 for the four CAMS Trailers for comparison purposes (data for 1976 only).

Of the four TACB monitoring locations for which data are presented in Table II-E-6, one station (Station 1, in east Houston) exceeds the federal secondary standard for 24-hour particulate samples. Three of the four stations (stations 1, 2, and 4) exceed

TABLE II-E-5

OTHER GASEOUS POLLUTANTS

Period	(ppm) Total Hydro-carbons 1 hr. 2nd high	Total Hydro-carbons % of hours exceeding 5 ppm	(ppm) Methane 2nd high, 1 hr.	(ppm) Hydrogen sulfide, 2nd high, 1 hr.	(ppm) Total sulfur 2nd high, 1 hr.	(ppm) Total sulfur, 2nd high, 24 hr.	(ppm) Nitric oxide 2nd high 1 hr.	(ppm) Nitric oxide 2nd high 24 hr.	(ppm) NO_X 2nd high 1 hr.	(ppm) NO_X 2nd high, 24 hr.
					STATION 1					
1976	9.8	10.5	8.1	0.02	0.17	0.02	0.91	0.24	1.06	0.31
1st qtr., 1977	8.7	9.2	8.5	0.01	0.09	0.01	0.72	0.11	0.81	0.15
2nd qtr., 1977	10.0	7.4	9.2	0.01	0.07	0.03	0.75	0.11	0.91	0.15
3rd qtr., 1977	9.9	9.5	9.3	0.02	0.02	0.00	0.25	0.05	0.32	0.09
					STATION 2					
1976	8.2	2.7	4.9	0.05	0.05	0.00	0.59	0.16	0.64	0.22
1st qtr., 1977	9.3	4.1	6.1	0.03	0.03	0.00	0.42	0.11	0.51	0.15
2nd qtr., 1977	8.7	2.3	6.7	0.00	0.00	0.00	0.37	0.07	0.48	0.12
3rd qtr., 1977	7.9	2.7	6.0	0.00	0.00	0.00	0.23	0.05	0.28	0.08
					STATION 3					
1976	9.0	3.8	6.1	0.01	0.27	0.01	0.46	0.09	0.49	0.14
1st qtr., 1977	2.2	0.0	1.7	0.02	0.01	0.00	0.14	0.02	0.18	0.06
2nd qtr., 1977	5.2	0.2	3.4	0.01	0.01	0.00	0.12	0.02	0.18	0.04
3rd qtr., 1977	6.6	1.6	4.9	0.00	0.00	0.00	0.05	0.02	0.08	0.03
					STATION 4					
1976	6.7	0.9	3.5	0.00	0.02	0.00	0.24	0.05	0.29	0.07
1st qtr., 1977	6.1	0.9	3.5	0.00	0.02	0.00	0.20	0.03	0.28	0.05
2nd qtr., 1977	6.4	0.4	3.0	0.00	0.00	0.00	0.19	0.05	0.32	0.08
3rd qtr., 1977	9.0	47.3	3.0	0.00	0.00	0.00	0.14	0.03	0.20	0.05

TABLE II-E-6

DATA FROM NON-CONTINUOUS HIGH VOLUME SAMPLING STATIONS

Station	Pollutant **	Max. 24-hour	24-hour second high	Annual geometric mean
Station 1	TSP	198	*162	!*90
	Nitrate	5.6	4.1	3.2
	Sulfate	24.2	22.0	8.3
Station 2	TSP	199	114	*69
	Nitrate	10.7	10.0	4.1
	Sulfate	29.1	25.1	7.7
Station 3	TSP	207	95	57
	Nitrate	4.1	3.7	2.8
	Sulfate	16.0	11.6	7.0
Station 4	TSP	185	110	*71
	Nitrate	3.6	2.5	1.4
	Sulfate	18.4	17.0	5.7

! = Exceeds primary standards

* = Exceeds secondary standards

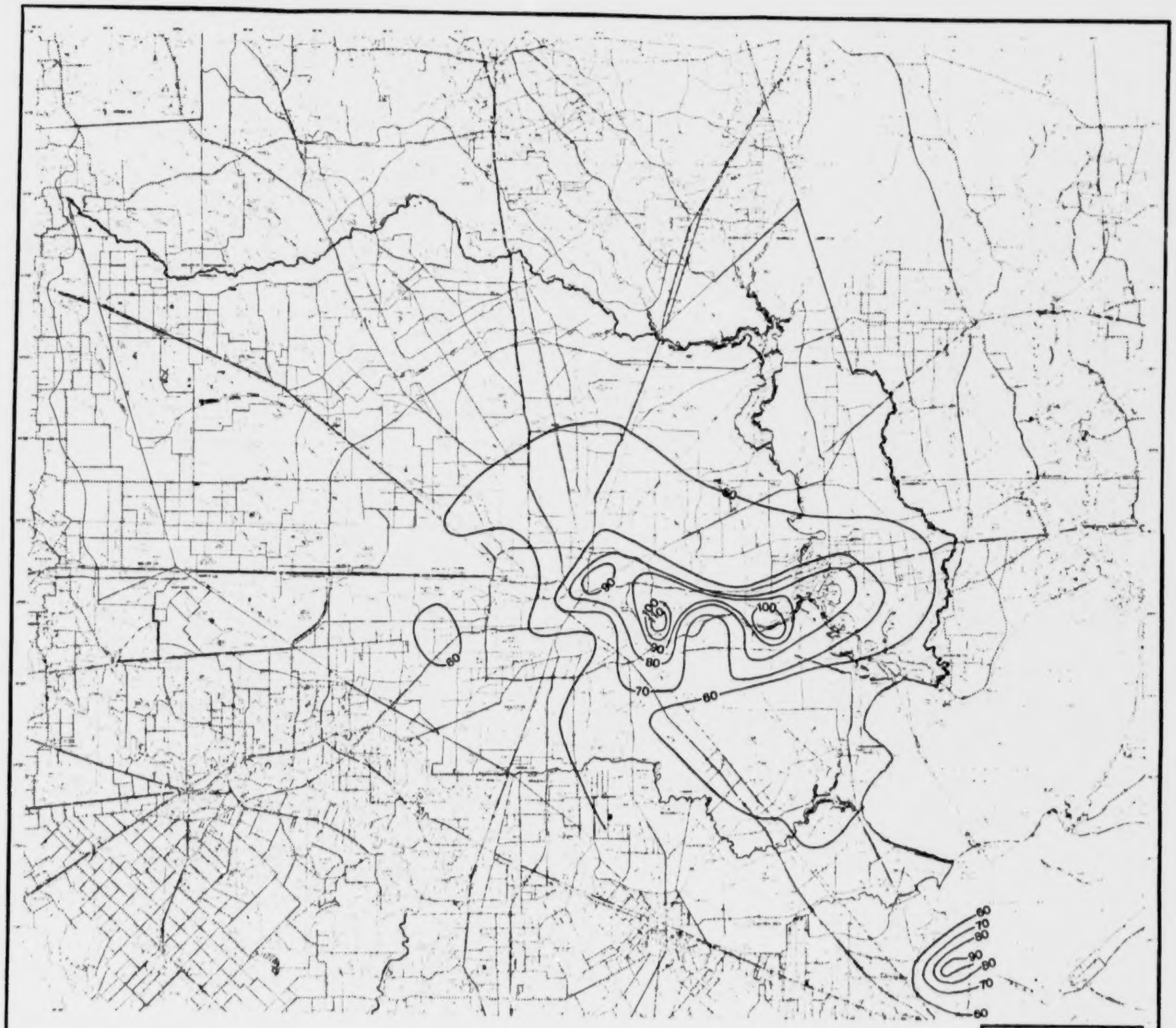
** TSP - Micrograms/m3
Nitrate - ppm
Sulfate - ppm

the annual average federal secondary standard for particulates, while Station 1 also exceeds the national primary standard calculated as a yearly geometric mean. All four stations also reported above average nitrate and sulfate levels in comparison with other monitoring locations throughout Texas.

Of the 59 particulate sampling locations in the Houston Air Quality Control Region (AQCR No. 7), one had levels which violated the national 24-hour primary standard for particulates during 1976, while fifteen violated the secondary standard for 24-hour levels. Considering the annual geometric mean, thirteen of the stations violated the national primary standard (75 $\mu gm/m^3$), while 36 out of the 59 stations violated the national secondary standard (60 $\mu gm/m^3$). Figure II-E-3 presents the annual average concentrations of total suspended particulates measured in the Houston-Galveston area during 1976. The particulate levels are highest in the eastern and northeastern sections of Houston, particularly along the Ship Channel, but relatively high particulate levels are fairly common throughout the Houston-Galveston area. The heavily industrialized sectors of the Houston-Galveston area have the highest concentrations. The expansion of the 60 micrograms/meter^3 isopleth far to the north and northwest of Houston (normally downwind from the Ship Channel and the industrialized sector) indicates that the Ship Channel and its many pollutant emittors are the chief particulate sources in the Houston area. Considering the above data, it is evident that AQCR No. 7 violates both the primary and secondary federal standards for particulates for short-term (24-hours) samples as well as for annual averages (geometric means). Although the particulate levels are somewhat lower in the western, southern and northern sections of AQCR No. 7, federal regulations specify that even if only one monitoring site within an AQCR exceeds an air quality standard, then the entire AQCR is considered to be in noncompliance with that standard. The ramifications of this law will be explained in a following section.

Current Sources of Emissions

Emissions data for 1973 from the Texas Air Control Board are used to locate the major stationary sources of air pollution in the Houston-Galveston area. Within the area encompassing the three subbasins of interest, the industrial complex of Harris County emits by far the greatest quantities of air pollutants per square mile. Most of these stationary sources of emissions are located in the southeastern quadrant of Harris County, in the area bounded by Interstate 10 East on the north, Interstate 10 South on the southwest, Clear Creek on the south, Galveston Bay on the southeast, and Cedar Bayou on the east. Considering the region encompassed by the three subbasins, the industries of Harris County are the source of 83.0



— LEVEL OF CONCENTRATION (micrograms/m³)

Areawide Waste Treatment Management Plan
HOUSTON AREA

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

PARTICULATES: ANNUAL
GEOMETRIC MEAN (1976)

percent of the NO_x (oxides of nitrogen) emissions, 99.7 percent of the SO_x (oxides of nitrogen) emissions, 99.7 percent of the SO_x (oxides of sulfur) emissions, 95.3 percent of the hydrocarbon emissions, 86.0 percent of the carbon monoxide emissions, 91.5 percent of the particulate emissions, 76.7 percent of the H_2S (hydrogen sulfide) emissions, 98.8 percent of the sulfuric acid emissions, and 100 percent of the fluoride emissions.

This breakdown does not consider the mobile sources in the region (i.e., the traffic-related sources). The traffic on Loop 610, Interstate 10, Interstate 45, and the Southwest Freeway (Highway 59) undoubtedly accounts for additional large emissions of hydrocarbons, carbon monoxide, particulates, and oxides of nitrogen. Reliable data on the emissions from mobile sources were not available.

Based on the 1973 emissions data, the approximate emissions from stationary sources for the three basins are presented in Table II-E-7.

The Houston Ship Channel Subbasin and adjacent sectors (i.e., parts of Chambers and Fort Bend Counties) produce an immense volume of pollutant emissions. The high levels of emissions are related to the high concentrations of the primary pollutants which are centered in the Ship Channel area. The annual average concentrations of pollutants generally decrease as a function of distance from the Ship Channel (Figures II-E-1, II-E-2, and II-E-3).

The region just south of the Clear Lake Subbasin (near Texas City) is highly industrialized. As a result of these emissions sources in the Texas City area, the ambient air quality in the southern portion of the Clear Lake Subbasin is reduced because of the high frequency of southerly winds (Figures II-E-1, II-E-2, and II-E-3).

Future Air Quality Conditions

Introduction

Land use projections for the next twenty years indicate that the Houston metropolitan area will continue to expand with the same growth patterns that presently exist. Residential areas will build in the northern, western, and southern sections of the district, while both industrial and residential expansions will occur in the eastern portion of the district, near the Houston Ship Channel. Therefore, the ambient air quality in the Houston-Galveston area will undoubtedly decrease somewhat, especially in the vicinity of the Ship Channel, unless additional controls on the emission of pollutants are implemented.

TABLE II-E-7

1973 EMISSIONS BY SUBBASIN (TONS PER YEAR IN 1973)

Subbasin	NO_x	SO_x	HC	CO	Part	H_2S
Lake Houston Subbasin						
Spring Creek Basin	254	0	96	1	6	0
Just Northeast of Spring Creek Basin	11700	171	4876	66900	534	559
Cypress Creek	1652	0	344	0	0	0
Houston Ship Channel Subbasin	155059	147734	272162	445682	40702	3618
West and Southwest of Houston Ship Channel Subbasin (Fort Bend County)	13694	251	962	170	1542	538
Just Across Cedar Bayou From Houston Ship Channel Subbasin (Chambers County)	21802	39	1762	4066	1455	--
Clear Lake Subbasin (incomplete)	9000	1500	25	56	202	

Note: 1975 data is now available

Discussion

The highly industrialized Houston Ship Channel presently releases more emissions than the atmosphere can disperse. In other portions of the Houston-Galveston area, the high volume of traffic also is responsible for the emission of large quantities of hydrocarbons, oxides of nitrogen, carbon monoxide, and particulates. These total emissions are causing high levels of several pollutants (e.g., hydrocarbons, particulates, and photochemical oxidants) throughout the Houston-Galveston area and high concentrations of several other substances (sulfur dioxide and nitrogen dioxide) in localized areas, particularly near the Ship Channel and in downtown Houston. Air Quality Control Region Number 7 is presently in non-compliance with federal ambient air quality standards for particulates, ozone, and hydrocarbons. The outlook for the ambient air quality of this region is poor, in view of the increasing volumes of emissions which are projected.

The AQCR containing Houston is presently classified as Class II region with respect to ambient air quality by the EPA. Under new prevention of significant deterioration (PSD) regulations which became effective on March 1, 1978, this Class II designation permits certain defined incremental increases in particulate and sulfur dioxide concentrations that are caused by new developments or sources of emissions. This classification is always subject to reconsideration. Such a review is possible in view of the present poor ambient air quality in the Houston-Galveston area and the need to control the immense volume of pollutants emitted in the region. The Texas Air Control Board has disagreed with many of the EPA's edicts on Houston's compliance with ambient air quality regulations, so the future severity of ambient air quality regulations imposed on the Houston area is still uncertain.

Assuming a minimum of federal intervention, the ambient air quality in the Houston-Galveston area may continue to deteriorate slowly. Emission control devices for automobiles will lessen the rate of traffic-related emissions, but the increased population of the Houston-Galveston area during the next two decades will negate the reduction in emissions per vehicle. Moreover, the continued development and expansion of the chemical and steel industries in the Ship Channel area will result in an increase in pollutant emissions in that district. The result may be increased concentrations of pollutants in the ambient air, particularly in the Houston Ship Channel Subbasin and in the Clear Lake Subbasin.

The meteorology of the Houston-Galveston area will not change significantly during the next two decades. The increased air pollution in the region could result in a higher frequency of occurrence of fogs in the district and could affect precipitation downwind of Houston (primarily north of Houston) in various ways. The continued expansion and development of the region could also strengthen the urban heat island that presently envelops the Houston metropolitan area. The strengthening of the urban heat island, in addition to raising the average temperature of the Houston-Galveston area slightly, could also have some secondary effects on precipitation intensities and distributions in the district. Finally, low-level wind fields may be affected by the continued development; wind speeds may be decreased by the frictional influence of buildings on the movement of air. This decrease in low-level winds could affect the ability of the atmosphere to disperse pollutants, thus further deteriorating the ambient air quality.

Summary and Conclusions

The meterology and climatology of the Houston-Galveston area are characterized by warm summers, mild winters, and abundant precipitation. Flooding and hurricanes constitute the primary hazardous meteorologically-related conditions in the area. The dispersive potential of the air is fair on a nationwide basis, but often is not adequate to dilute sufficiently the emissions from the concentrated industrial sector along the Houston Ship Channel.

The Houston-Galveston area has relatively poor ambient air quality on a regional basis at the present time. Within Texas, only the El Paso area, which is enveloped by smelters and mountainous terrain, has similar ambient air quality. The pollutant concentrations are highest in the Ship Channel area, where the majority of the sources of the emissions are located. The northern parts of the Houston metropolitan area, especially the Lake Houston Subbasin, have relatively good ambient air quality However, the question of the compliance of an area with federal air quality standards is decided on an AQCR basis; the Houston AQCR (No. 7) does not comply with federal standards for particulates, non-methane hydrocarbons, and photochemical oxidants. Most of the excursions of the standards occur in the Ship Channel area. The highest annual average isopleths of particulates and the second highest 24-hour average isopleths of sulfur dioxide follow the course of the Ship Channel. The highest concentrations of nitrogen dioxide, which is generated primarily by automobiles, are located in the center of Houston.

The meteorology of the Houston-Galveston area will not change appreciably in the future. Possible slight changes in the meteorology of the region include urban heat island effects, precipitation alteration, fog enhancement, and changes in the low-level winds. Some of these effects are beginning to appear at present, but will likely be intensified during the next two decades.

The future ambient air quality in the Houston-Galveston area is likely to deteriorate somewhat, based on the assumptions that industrialization of the Ship Channel area will continue and that the population of the Houston-Galveston area will continue to increase. The future ambient air quality will probably be poor in the Houston Ship Channel Subbasin, fair to poor in the Clear Lake Subbasin, and fair in the Lake Houston Subbasin. If the federal regulatory agencies, principally the FPA, decide to tighten the air quality regulations which have thus far allowed the rapid expansion in the Houston-Galveston area, major changes in land use, transportation, and industrialization patterns could be necessitated. At present, the ambient air quality regulations and classifications are favorable for continued growth in the Houston-Galveston area.

CHAPTER II-F
PUBLIC HEALTH

Introduction

Water Borne Pathogens

The public health of the population in the 208 planning area is of major importance. Classically, fecal coliform bacteria have been used as an indicator of the presence of pathogenic organisms in a body of water. Many standards exist which define an acceptable level of fecal coliform in waters used for human contact. These standards range from 2000 MPN/100 ml* in some eastern states to 200 MPN/100 ml for some stream segments in Texas. It is generally recognized that no single correct fecal coliform standards exists. The regional standard or goal therefore must be the result of reasoned judgment. The 200 MPN/100 ml goal in the HGAC study area is the result of such judgment and is a conservative number, in that studies have shown that fecal coliform numbers an order of magnitude higher in contact recreation waters in other parts of this county have had no adverse public health effects.

Other Substances with Possible Adverse Public Health Effects

It is widely recognized that substances other than pathogenic organisms can be harmful to public health when present in water with which the public is in contact.

In 1976 the United States Environmental Protection Agency published Quality Criteria for Water in which the major substances which can pose a threat to public health are listed. Several of the more important of these substances and their criterion as reported by EPA are listed in Table II-F-1.

Reference should be made to the previously mentioned EPA document for a more thorough analysis of the effect on public health of these substances. The public health effects of air borne pollutants such as carbon monoxide and hydrocarbons is addressed in the chapter of this report dealing with air--Chapter II-E.

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* MPN/100 ml = most probable number of fecal coliform organisms per 100 milliliters.

TABLE II-F-1

CRITERION FOR SELECTED POTENTIALLY HARMFUL SUBSTANCE

Substance	Use	Criterion	Potential Health Effect
Arsenic	1	50 μg/l*	internal organs
Barium	1	1 mg/l*	intestinal tract
Beryllium	1	11-11000 μg/l	skin "burns"
Cadmium	1	10 μg/l	absorbed in tissues - bones
Chromium	1	50 μg/l	hyperglycemia
Copper	1	1.0 mg/l	liver damage
Cyanide	2	5 μg/l	inhibits oxygen metabolism
Iron	1	0.3 mg/l	aesthetic
Lead	1	50 μg/l	nerve and brain damage
Manganese	1	50 μg/l	liver damage
Mercury	1	2.0 μg/l	neurological and intestinal damage
Nitrates, Nitrites	1	10 mg/l (N)	inhibits oxygen transport
Oil, Grease	1	free from oil and grease	fish tainting
Aldrin-Dieldrin	2,3	0.003 μg/l	cancer
Chlordane	2	0.01 μg/l	cancer
DDT	2,3	0.001 μg/l	cancer
Endrin	1	0.2 μg/l	based on fishkill
Heptachlor	2,3	0.001 μg/l	cancer
Lindane	1	4.0 μg/l	based on fishkill
Malathion	2,3	0.1 μg/l	brain damage in fish
Mirex	2,3	0.001 μg/l	based on animal deaths
Parathion	2,3	0.04 μg/l	blood, intestinal, nerve damage
Toxaphene	1	5 μg/l	physiological effects in animals
Phenol	1	1 μg/l	based on fishkill and fish tainting
Polychlorinated Biphenyls	1,2,3	Every reasonable effort should be made to reduce human exposure.	highly toxic to liver and reproductive system
Selenium	1	10 μg/l	internal organisms
Silver	1	50 μg/l	skin discoloration

* μg/l = 10^{-9} grams per liter of water

* mg/l - 10^{-6} grams per liter of water

[1] domestic water supply

[2] freshwater aquatic life

[3] marine aquatic life

Present Conditions

A segment-by-segment statistical analysis was performed on the coliform bacteria level of selected stream segments in the HGAC planning area. The results of this analysis are presented in tabular form in Chapter II-D of this report. The statistical analyses show that several segments have fecal coliform levels which pose a serious public health problem. These segments are Spring Creek, Cypress Creek, Clear Lake, Clear Creek Tidal, Dickinson Bayou Tidal, Clear Creek Nontidal, and the Turning Basin, Upper and Lower Houston Ship Channel. The segments which comprise the Houston Ship Channel pose the most serious public health problems. The reader is referred to the statistical data available in Chapter II-D of this report for a more detailed statistical analysis of these problems.

CHAPTER II-G
BIOLOGY

Introduction

The greater Houston 208 Study Area lies in the southeast corner of Texas in the Gulf Coastal Plain. The environment is characterized by a mixture of tidally influenced lakes and rivers, saltwater and brackish water marshes, upland prairies, hardwood forests, mixed pine and hardwood forests, and freshwater marshes and swamps. Because of diversity of available habitats, the area supports a large group of wildlife. The wetland areas provide the habitat for water fowl and nursery areas for fish and shellfish and American Alligators. The upland areas, although they lack the high productivity levels of the wetlands, provide important habitats for game animals and birds. The area also contains several animals which are protected under federal law and many plants for which concern is being expressed by various state groups and agencies. Although the vast majority of the land has felt the effects of man's activities, there are areas around Houston that still reflect the natural or wild state of the environment that existed over one hundred years ago.

The area is also the site of the most actively growing human population in the United States. Proximity to both the Gulf of Mexico and the resources of the State of Texas have permitted Houston to become one of the most successful seaports and industrial areas of the world. Historically, this development proceeded without regard for the damage that was inflicted upon the region's natural systems. Swamps and marshes were drained or filled. Rivers and streams were channelized. The surface of the land was used only as human necessity or practicality dictated. The smaller streams in rural areas are receiving the pesticides and silt from agricultural runoff. The streams and rivers near more intensively developed areas receive other pollutants more characteristic of industrial activities. The realization that the economic health of a region depends not only upon the quantity of industrial and commercial activities but also on the state of the natural surroundings has led to the initiation of laws which attempt to curtail degradation of the natural environment. The complex interaction that has developed between economic conditions, antipollution legislation and natural environmental quality has necessitated the instigation of long-range planning projects. These projects attempt to define a strategy which will allow an acceptable level of economic activity without excessive destruction of the environment.

Current Environmental Conditons

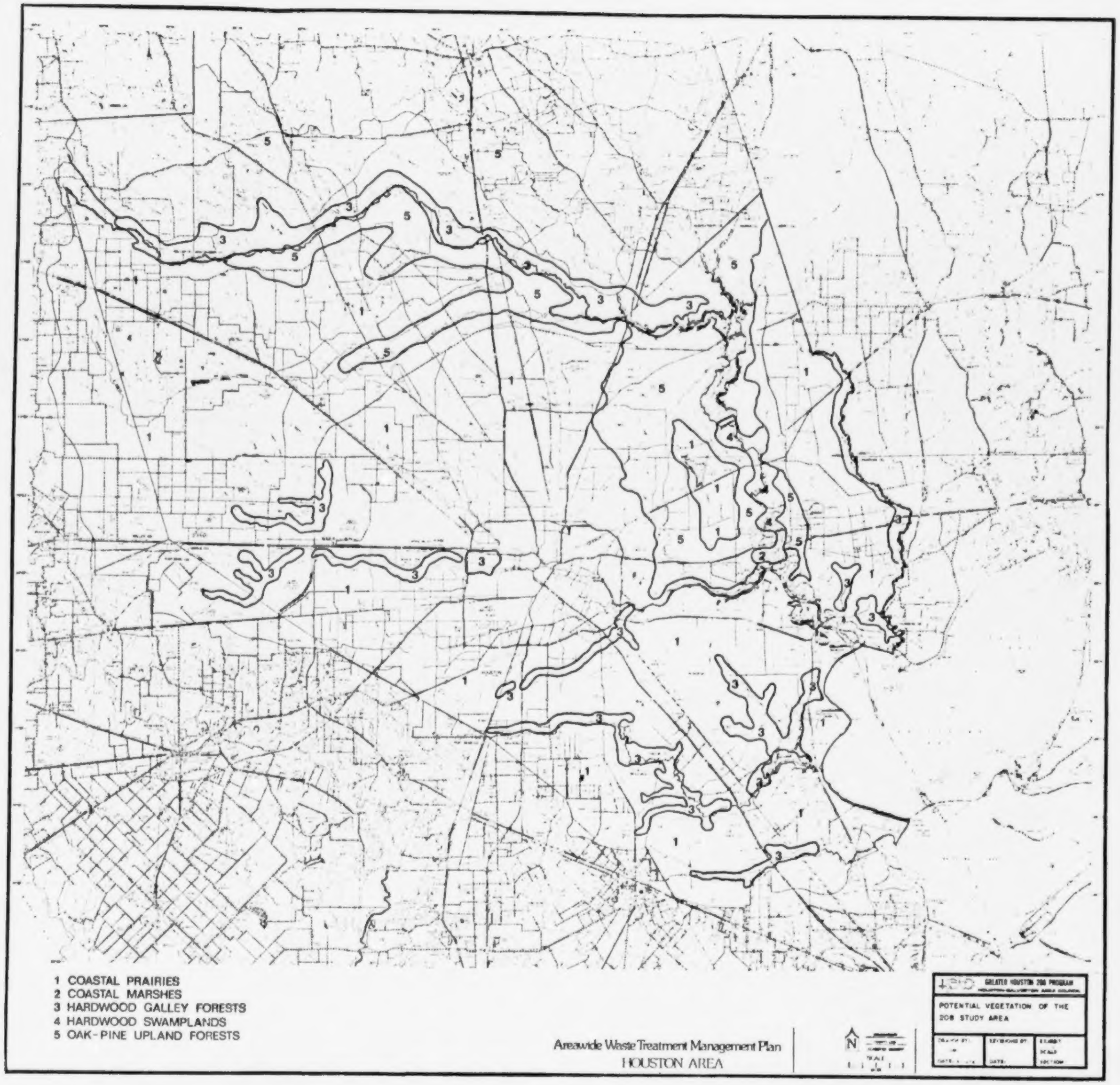
A description of current biological conditons of the 208 area must consider a broad range of topics. Because of the non-site-specific nature of the 208 Plan, this report will describe typical or average sites located in the region including the vegetation types and wildlife habitats. Wildlife that has the potential to occur in the region and endangered organisms which may be located in the area will be identified. This section will also furnish the basis for estimating the value of existing sites in the area which remain in a relatively natural condition. Known unique natural areas found in the 208 area will be discussed.

Vegetation

The vegetation of the Houston area consists of marshes, prairies and forests. These three broad categories of plant habitats can be more accurately broken down into several classes. These classes will be discussed both from the standpoint of vegetation and from the animals which typically inhabit them. Figure II-G-1 depicts the distribution of vegetation types in the 208 area.

Coastal Prairies and Marshes. The prairies and marshes found in the 208 area are associated with the more recently deposited alluvial soils and consist of very fine clays. This soil and vegetation type are generally restricted to the lower one-half of the study area. A significant portion of the marsh/prairie complex has been developed for housing and industrial development although the majority is currently used for agricultural activities. The moist prairies south of Buffalo Bayou are excellent areas for rice cultivation and pasture or rangeland for cattle. The prairies north of Buffalo Bayou become more important as pasture and rangeland although the cultivation of rice is practiced where adequate subsurface water is available.

There are two prairie types located within the 208 area and three different marsh types. The marshes can be differentiated by the composition of the vegetation and generally by the access to or influence of saltwater sources. The prairies are different both in the kinds of plants and the substrate on which they are found. Marshes can also be wetlands when temporarily or intermittently covered with water. All of the marsh/prairie habitats are preferentially utilized by different categories of wildlife. Each habitat can be considered an important asset to the local ecological system.



1 COASTAL PRAIRIES
2 COASTAL MARSHES
3 HARDWOOD GALLEY FORESTS
4 HARDWOOD SWAMPLANDS
5 OAK-PINE UPLAND FORESTS

Areawide Waste Treatment Management Plan
HOUSTON AREA

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

POTENTIAL VEGETATION OF THE 208 STUDY AREA

DRAWN BY: DATE:	REVISIONS BY: DATE:	EXHIBIT SCALE SECTION

The Coastal Marsh. The marshlands found in the 208 area range from saltwater and brackish water marshes near Clear Lake in southern Harris County to freshwater marshes located in the San Jacinto River basin in northern Harris County. All coastal marshes are an integral part of the estuarine nursery system. Through basic plant growth and decomposition processes, they produce most of the nutrient needs of estuarine organisms. In the process, a portion of the excessive man-caused mineral and organic wastes, such as phosphorus and oil, are removed from surface water systems. Through this function, such wetlands not only help meet wildlife nutrient needs, but assist in maintaining good water quality.

Many commercial and sports species in the bays and in the Gulf of Mexico are dependent on coastal marshes which serve as nursery habitats or as food sources for these important species. Many marine fish species that never enter or directly utilize the estuaries are nevertheless dependent on the bays and associated wetlands through continued enrichment of the food sources of the open gulf habitat. Thus, the coastal wetlands are the basis for a complex food chain which extends from the wetlands to the open sea.

In addition to fishes, a variety of other types of wildlife inhabit or depend on the coastal wetlands. A variety of migratory and other aquatic birds depend directly or indirectly on wetlands for their life needs. Hundreds of thousands of ducks, geese, and other birds winter on the Texas coast every year providing hunting and other recreational opportunities for residents of the region and the State. Many terrestrial mammals such as rabbits, rats, raccoons, skunks, and coyotes also live in these coastal marsh areas or in the adjacent coastal prairie grasslands. Red wolves, an endangered species, frequent the coastal wetlands. Four furbearing species, the beaver, otter, muskrat, and nutria, live in the marshes and along associated waterways. Finally, a great many reptiles and amphibian species, including the American Alligator, frogs, turtles, and venomous and non-venomous snakes depend on the coastal wetlands.

Inland wetlands and associated vegetation also help to regulate the movement of surface waters. Marshes and swamps, in particular, help to slow runoff and stream discharge, thus acting as a stabilizing agent. Proposals to drain or fill wetlands should take into account the likelihood of subsequent additional costs for artificial flood control.

Inland wetlands, composed of swamps, freshwater marshes, and intermittent lakes also serve a number of beneficial functions.

As with coastal wetlands, excessive mineral and organic wastes are removed or transformed, through the plant growth process, resulting in improved water quality and nutrient production that is of benefit to a variety of wildlife species.

Several commercially important furbearing species, including beaver, otter, muskrat, and nutria, are dependent on water features such as swamps and freshwater marshes. These areas are also important habitats for endangered species such as red wolves and alligators.

The Coastal Prairie and Grasslands. The prairies located on the 208 area consist of native grasses supported by clay loam soils. The soils allow the infiltration of rainwater and seldom maintain accumulations of surface water. Prairies and grasslands are usually located in areas which tend to have higher elevations so surface runoff is quickly fed into stream channels. Whereas the wetlands were important for aquatic and estuarine organisms, the prairies provide equally important habitat for terrestrial organisms. Much of the prairie habitat has been placed in agricultural use as pasture and rangeland.

Coastal prairies and grasslands, along with upland forests, are the least sensitive to water quality conditions. However, these areas are often sources of pollution when runoff enters nearby creek channels. Where prairie plant cover is removed either by grazing, intensive crop agriculture, or construction, the result is often an increase in erosion and the removal of soil to nearby creeks and rivers. Use of lands in this manner also decreases the ability of the land to support native wildlife. Perhaps the most obviously affected wildlife species is the Attwater's Prairie Chicken. This species has come under federal protection as an endangered species. Prairies which provide habitat for the Attwater's Prairie Chicken are found in the 208 area, but future projections for the survival of this species near Houston are in doubt.

The Forests

Forests in the 208 area can be classified into three basic types. Water tolerant hardwoods are distributed as gallery or floodplain forests along the creeks and rivers. Within the San Jacinto River Basin, a few areas of permanent standing water support a true swamp vegetation. The upland areas are characterized by a pine hardwood forest.

The most characteristic vegetation of the 208 area is perhaps the dense, water tolerant hardwood trees growing adjacent to area streams. This forest type is most predominant along the north side of Clear Lake, near Cedar Bayou and north of Lake Houston along the San Jacinto River. Narrow, gallery forests of water tolerant hardwoods follow most of the stream channels. The forests adjacent to Buffalo Bayou at Addicks and Barker Reservoir are an example of this forest type.

These gallery forests are an important element in the local ecology because they comprise a constrasting habitat from the adjacent grasslands. Many organisms can therefore use the forests for one habitat requirement and the nearby open areas for another. This habitat diversity is necessary for the survival of a large number of different wildlife species. Important examples would be deer and predacious birds. These areas are also heavily utilized by both fox and gray (cat) squirrels because of the abundance of food materials produced in these areas.

Gallery hardwood forests are an important natural element in flood control as they provide resistance to flood waters overflowing the stream channel. This has the effect of retaining these waters temporarily and subsequently releasing them to the receiving channel (bank storage). Areas adjacent or upstream, however, may be subject to flooding caused by these retained waters and the current practice is to channelize the streams in order to ensure a rapid removal of surface waters following heavy rains. This channelization process, however, initially requires the removal of a portion of the stream-bank forests and also destroys the aquatic conditions that supported the water tolerant trees. Important wildlife habitats can be destroyed by this process. Rapid removal of stormwaters can also result in increased sediment loading and siltation in downstream locations.

The upland forests consist of a mixture of pines and hardwoods. The soils of these forests are moderately permeable and do not permit surface accumulations of water. These forests are distributed along the western side of the San Jacinto River and also in the extreme north edge of the HGAC area. They form an important forest resource for timber production and are important wildlife habitats. Two endangered species, the red cockadded woodpecker and the Houston toad utilize these upland areas for habitats.

Swamps found in the HGAC area reach notable size only in the San Jacinto River Basin below Lake Houston. Other smaller-size sites are distributed throughout the area along larger streams. Swamps are extremely important wildlife habitats because they support a unique group of animals. Swamps and adjacent forested areas provide habitats for the Southern Bald Eagle and to a lesser extent for the American alligator. Both of these organisms are currently protected by federal laws.

Freshwater Fishes

To establish a proper basis for evaluating the incremental improvements in water quality which will result from 208 pollution control alternatives, the organisms likely to be affected should be identified. Important "fishable" species within freshwater reaches of the 208 study area include many members of the centrachid family (largemouth bass, black and white crappie, warmouth, spotted bass, and various sunfishes), catfish (channel catfish, blue catfish, flathead catfish, and bullheads), and larger "rough" fish (carp, bowfin, smallmouth buffalo, and freshwater drum). Local fishermen are primarily interested in these fishes because of their size, abundance, and value as gamefish or food. These fish are found in the portions of coastal rivers upstream from tidal influence and associated saltwater intrusion. Almost all of these fishes are yearlong residents of individual stream segments during all stages of their life history. Except for some limited upstream migrations by spotted bass and some catfish during the spawning season, these fish reside and reproduce within a limited home range.

Large reservoirs near the 208 study area, such as Lake Houston, force effective limits on upstream migration, while the saltwater interface determined by tidal action marks the downstream distribution boundary. During episodes of high streamflow, some freshwater fishes can be washed into previously estuarine habitat, but these displaced fishes usually return upstream when flow decreases and ambient salinity levels increase. No native fishes with an anadromous life history are known; however, current transplantation programs by the Texas Parks and Wildlife Department into East Texas reservoirs may introduce viable populations of this migratory gamefish. If stocking succeeds, striped bass may become transients in the future.

Water Quality - Biota Relationships

To understand the water quality-biota relationships within local aquatic environments, two kinds of basic ecological information are needed: (1) the environmental limits of major resident species and (2) the expected environmental transport and behavior of major water quality constituents. From this information, one can determine which constituents will have the greatest impact on meeting "fishable-swimmable" objectives. In addition, these relationships are the key to determining the types and magnitude of environmental quality changes that will result from water quality improvements.

Many of the environmental relationships between water quality and estuarine or freshwater biota are not known, especially those which relate to sublethal, chronic stresses. Even when extensive laboratory and field testing has established a tentative relationship between a specific water quality constituent and a particular biologic species, that relationship may be enhanced or negated by the combined effects of other physical and chemical (quality) conditions that exist in the natural environment. To determine a set of environmental limits on each species would require an exhaustive and perhaps fruitless literature search, and even then the gaps in our knowledge of causal relationships would probably make it impossible to define a critical concentration or parameter level that was applicable to all of the different aquatic environments and biota present in the 208 area. A more rational approach would be to utilize established quality criteria for aquatic life that have been developed by the Environmental Protection Agency, and which is based on previous work to determine relevant criteria by the State of California in 1952, the Federal Water Quality Administration in 1968, and the National Academy of Sciences in 1974. Each of these efforts has attempted to use historical literature data and current research results to establish state-of-the-art criteria which insure adequate protection for even the most sensitive aquatic organisms. A list of these criteria, based on a constituent level needed to maintain desired water use, is presented in Table II-G-1. Ambient environmental levels above the prescribed values are indicative of potentially serious environmental effects and the need for more stringent standards on waste discharges.

Known Environmental Limits

The environmental conditions that are conducive to the existence of aquatic organisms (including all tidally-influenced waterbodies) are essential elements of any discussion of water quality-biota relationships within the 208 study area. It is important to know which water quality and physical environmental parameters affect the abundance and distribution of major indigenous species, particularly those finfish and crustaceans of obvious value to a commercial fishery, recreational sports fishery, or related food chains. Such useful information regarding these requirements can be determined from known relationships in a similar estuary with geographical proximity. Previous studies have attempted to identify optimal physiochemical conditions for major estuarine species by analyzing conditions at the time and location of capture. The basic premise that aquatic organisms seek an optimal set of environmental conditions is ecologically valid.

Because of the abundant historical data on salinity and temperature, these two parameters can be correlated with individual species preferences more easily. The relationships between other water quality

TABLE II-G-I

QUALITY CRITERIA FOR WATER ESTABLISHED BY THE ENVIRONMENTAL PROTECTION AGENCY

Water Quality Parameter	Criteria	Principal Areas of Concern
Ammonia (Un-ionized)	0.02 mg/l	Freshwater aquatic life
Arsenic	500-100 μg/l	Water supply
Barium	1 mg/l	Water supply
Boron	750 μg/l	Irrigated crops
Cadmium	0.4-0.12 μg/l 4-12 μg/l 5 μg/l	Sensitive freshwater organisms Less sensitive freshwater organisms Marine life
Chlorine (residual)	10 μg/l	Aquatic life (freshwater and marine)
Chromium	100 μg/l	Freshwater aquatic life
Fecal Coliform Bacteria	200/100ml 14/100ml	Contact recreation waters Shellfish harvesting waters
Cyanide	5 μg/l	Aquatic life
Iron	1 mg/l	Freshwater aquatic life
Lead	50 μg/l	Water supply
Manganese	100 μg/l	Marine mollusks
Mercury	0.05 μg/l 0.10 μg/l	Freshwater aquatic life Marine aquatic life
Nitrate (nitrogen)	10. mg/l	Water supply
Dissolved Oxygen	5 mg/l	Aquatic life
Pesticides: Aldrin-dieldrin	0.003 μg/l	Aquatic life
Chlordane	0.01 μg/l 0.004 μg/l	Freshwater aquatic life Marine aquatic life
2, 4-D Herbicides	100 μg/l	Water supply
DDT	0.001 μg/l	Aquatic life

TABLE II-G-1 (CONTINUED)

Water Quality Parameter	Criteria	Principal Areas of Concern
Demetron	0.1 ug/l	Aquatic life
Endosulfan	0.003 ug/l	Freshwater aquatic life
Endrin	0.004 ug/l	Aquatic life
Guthion	0.01 ug/l	Aquatic life
Heptachlor	0.001 ug/l	Aquatic life
Lindane	0.01 ug/l 0.004 ug/l	Freshwater aquatic life Marine aquatic life
Melathion	0.1 ug/l	Aquatic life
Methoxychlor	0.03 ug/l	Aquatic life
Mirex	0.001 ug/l	Aquatic life
Parathion	0.04 ug/l	Aquatic life
Toxaphene	0.005 ug/l	Aquatic life
pH	6.5-9.0 6.5-8.5	Freshwater aquatic life Marine aquatic life
Phenol	1 ug/l	Aquatic life (tainting)
Phthalate esters	3 ug/l	Freshwater aquatic life
PCB's	0.001 ug/l	Aquatic life
Dissolved solids: chlorides	250 mg/l	Water supply
sulfates	250 mg/l	Water supply
Hydrogen sulfide (undissociated)	2 ug/l	Aquatic life
Copper, Lead, Nickel Oil and Grease, Selanium, Silver, and Zinc	Variable (0.01 x 96-hour LC_{50} value for sensitive resident species)	Aquatic life

parameters and the resident biota are much more tenuous. Under such conditions, the established quality criteria for a given constituent provide valuable guidelines as to an organism's tolerance.

Environmental Relationship of Water Quality Parameters to Aquatic Species

Because certain water quality parameters are more likely to impact the achievement of fishable-swimmable objectives within the 208 area, these parameters and their ecological relationships will be discussed here. Dissolved oxygen concentrations, pH range, temperature relationships, toxic materials, and fecal coliforms are important measures of man-generated waste discharges and associated effects on local environmental quality. Designated stream standards have been established for most of these quality parameters, so progress in enhancing local water quality can be evaluated directly from the water quality data base and current monitoring data. Those parameters not discussed here should not be classified as unimportant, especially if the ambient levels exceed established criteria for the protection of aquatic life and other beneficial uses of water.

Dissolved Oxygen

The level of dissolved oxygen in waters of coastal marshes, tidal creeks and bayous, and estuarine shallows is dependent upon basic environmental and hydrologic characteristics, as well as the varied point and nonpoint pollutant discharges into the estuarine complex. Inadequate flushing of small tidal creeks increases the retention time of oxygen-demanding organic and nitrogenous wastes within the water column and results in serious episodes of oxygen depletion. The presence of salt wedges (density stratification) and saltwater fronts (vertical interface) in coastal rivers and bayous inhibits vertical mixing and retards downstream movement or dilution with oxygenated estuarine waters. Lowered solubility of oxygen in brackish water and saltwaters intensifies the effects of dissolved oxygen consumption (both biological and chemical demands); this factor is particularly important in vertically stratified situations where the higher salinity bottom waters must contend with both aqueous (transported substances) and benthic (inplace) oxygen demands. Oxygen variations with depth are likely in most tidal creeks with insufficient flow to prevent saltwater encroachment and vertical density stratification. Natural turbulent reaeration apparently has little effect on ambient dissolved oxygen levels because of typical low flow velocities and minimal tidal mixing.

Biological and water quality characteristics of area watercourses also have substantial effects on ambient dissolved oxygen levels. Wind-generated reaeration is a major contributor of dissolved oxygen to areas with exposed surface water (i.e., marsh lakes and swales, estuarine shallows and tide flats, coves, wide coastal rivers, etc.); however, meandering bayous and coastal rivers with thick stands of hydrophilic vegetation along the banks are less affected by wind action and subsequent reaeration.

Photosynthesis by aquatic phytoplankton and macrophytes is another source of dissolved oxygen in aquatic systems. Oxygen is released as a byproduct of this daytime biochemical process, although some oxygen is consumed by the primary producers themselves. Nutrient levels within area waterways are generally sufficient to support a large photosynthetic community throughout the year. Open surface waters have phytoplankton and diatom communities which vary with prevailing salinity conditions and temperatures. In many cases, available light in the euphotic zone (depth of the water column with sufficient light to sustain photosynthesis) may regulate the extent of photosynthetic oxygen production. Turbidity caused by high suspended solids limits light penetration and causes some algae to settle out. Color resulting from natural organic decomposition products in dystrophic swamp and marsh waters can also limit light penetration, but concurrent turbid conditions often negates the impact of dark-colored waters.

Although light limitation in tree-shaded, turbid creeks and inland bayous can inhibit planktonic and attached algae, floating macrophytes often proliferate under these conditions. Duckweed and water hyacinths may cover the entire water surface when downstream flow and tidal action are insufficient to disperse the thick mats. When these forms of floating vegetation do cover the water surface, wind-aided reaeration is diminished as well as subsurface primary production due to decreased light penetration. Ambient dissolved oxygen levels are impacted through limitations on both types of natural reaeration. Seasonal dieoffs of floating macrophytes contribute new organic matter for bacterial decomposition which in turn releases more nutrients and consumes additional dissolved oxygen in the water column. This natural dieoff process may be beneficial to the estuarine areas downstream in terms of particulate organics and nutrient inputs; but, when coupled to significant man-generated waste discharges and poor flushing characteristics, it compounds local water quality problems, especially in regard to dissolved oxygen.

pH

Another water quality parameter of concern is pH -- a measure of hydrogen ion activity in aqueous solutions. This parameter is related to acidity (amounts of carbon dioxide and natural organic acids) and alkalinity (a measure of natural buffering capacity through the carbonate-bicarbonate system), but does not measure either. In freshwater systems, a pH range of 6.5-8.5 denotes productive habitat for aquatic organisms. Some fish may live in waters with pH as low as 4.0-4.5, but the population sizes and species diversity are likely to be severely limited. Values of pH in productive freshwaters may exceed 8.5 naturally since the consumption of carbon dioxide by primary producers during daylight hours alters the carbonate buffer equilibrium and the pH rises.

Values of pH outside the normal range may exert acute toxicity stresses on aquatic organisms directly or through release of free carbon dioxide under acid conditions (low pH) or un-ionized ammonia during highly basic conditions with strong alkalies present. Changes in pH may increase the mobilization of metal ions and nutrients from the sediments or within the water column itself. This phenomena works to make nutrients available to primary producers.

Temperature

The effect of temperature on aquatic organisms varies with biological parameters, such as species type, stage of life history, and physiological state. Organisms are capable of withstanding a wide range of ambient temperatures; however, each organism typically reacts to three differential zones within its "normal" temperature range; (1) lethal temperature range (metabolic death at extreme high and low temperatures), (2) stress loading temperature level (acute metabolic stress with subsequent inhibition of growth and normal activity), and (3) reproduction stress temperature (metabolic stress level resulting in inhibition of normal reproduction). All of these physiological response levels are generally considered when establishing temperature criteria for natural waterbodies.

If natural meteorological conditions exceed the acceptable ranges for the various physiological states, that habitat may cease to support viable populations of a particular species and the organism's distribution will become limited temporally, spatially, or both. Man-generated contribution of waste heat into aquatic systems can have significant impacts on the resident fauna and flora if thermal additions cause ambient conditions to exceed normally acceptable temperatures in terms of physiological stress on organisms. This is particularly important during the summer months when daily maximum temperatures are already close to stress - or mortality-induced levels. However, heated power plant effluents during winter months may provide a haven for estuarine organisms that might normally depart the system for the more stable thermal regime in deeper offshore waters.

Combinations of abnormal temperature and other stressful water quality conditions (low dissolved oxygen, high dissolved solids levels, extreme pH levels, or heavy metals, pesticides, and other toxics) can synergistically enhance the toxicity of a given water quality regime to the resident fauna. Natural temperature extremes may create high local mortality (i.e., winter freezes of shallow estuarine waters), but the overall effects on the resident population are limited and selective, since many motile organisms can move to deeper waters where thermal conditions are more hospitable. (Because of the thermal buffering properties of water in reducing drastic diel variations in relation to variations in local atmospheric temperatures, daily fluctuations in temperature are not likely to present any serious difficulty to the resident fauna in open waters.)

Continuous elevation of ambient temperature levels by waste heat discharges can result in alterations of local community structures that favor thermophilic species. This artificially-induced ecological succession may bring about growths of "nuisance" organisms (i.e., thick attached algae mats) that reduce the water quality, aesthetic attributes, and ecological diversity of the impacted habitat.

Toxic Substances

Waste products that exert toxic effects on aquatic organisms are discharged into the aquatic environment from numerous point and nonpoint sources. Pesticides (i.e., herbicides, insecticides, and other synthetic organic compounds toxic to terrestrial organisms) are used extensively in agricultural/silvicultural activities and can cause similar mortality among aquatic species when irrigation return flows or surface runoff transport these toxic forms into receiving waters. Industrial processes are the primary contributor of heavy metals to local waterways; however, dispersive uses of chemicals containing heavy metal complexes also contribute significant amounts, as in the cases of leaded gasoline or mercury-treated seeds. Various types of oils, refractory organics released as waste in the refining process, and refined petroleum products exhibit differential toxicity to aquatic life when spilled, discharged, or otherwise released into the aquatic environment.

Since toxic materials, such as pesticides and oils, are not completely water-soluble, their environmental transport mechanisms often involve interactions with suspended solids in the water column, deposition as sediment, and later mobilization from the sediments through biological regeneration or physiochemical reactions. Heavy metals also adhere to sedimentary particles and are transported along with the suspended solids component. In estuarine and brackish systems, this mode of environmental transport is significant in explaining low aqueous concentrations of toxics and yet the presence of localized sediment deposits with relatively high concentrations of heavy metals, oils, and pesticides. Physical and chemical coagulation processes acting on suspended solids, particularly the fine clays characteristic of turbid East Texas coastal streams and bayous, cause these fine particles to settle out as salinity levels increase. Residual toxicity in such deposits may inhibit resident benthic communities. Ultimately these absorbed toxics may be re-suspended by wind action, tidal movements, and downstream flows where they can affect nektonic communities.

Most of the chlorinated hydrocarbon pesticides are toxic to aquatic organisms in very small concentration (1 mg/l or less). Table II-G-1 gives the criteria for acceptable minimum concentrations for a number of widely-used pesticides. Many of these specified aqueous concentrations are not exceeded in data on normal river inflows or ambient background levels throughout the study area; however, the "first flush" phenomena following a large storm event is capable of transporting significant runoff quantities of recently-applied pesticides or absorbed pesticide residuals from agricultural lands and residential-suburban areas into nearby receiving waters. If the environmental half-life of the substance is sufficiently long, the toxic material has a good chance of being regenerated, taken up by aquatic organisms, and bioconcentrated through food web dynamics and selective physiological storage in fat-rich tissue. Ultimate toxic effects may not involve acute toxicity and direct mortality, but inhibition of normal reproduction processes or delayed mortality of adults under severe physiological stress from other water quality paramaters are just as serious to the resident community and its ecological integrity.

Sediments with a high oil content will prevent normal benthic populations and oil coatings will inhibit settling of oyster spot, barnacle larvae, and certain planktonic life stages of sessile organisms. The Houston Ship Channel below the turning basin exhibits persistent deposits of oily sediments, and normal repopulation of this deadened channel will probably take longer than other estuarine habitats if and when all oil and grease discharges into it are stopped.

Region VI of the Environmental Protection Agency has proposed a set of guidelines concerning the acceptability of moving dredged sediments into approved spoil areas. In order to insure that various toxic pollutants are not mobilized to impact the aquatic biota within estuarine areas, criteria for several chemical and water quality parameters as sediment components have been proposed. These criteria can be used to determine if contaminated sediments can be removed safely during the dredging process and not seriously impact the quality of both the dredging and disposal sites. The recommended criteria above which inplace polluted sediments should not be dredged are presented in Table II-G-2.

Fecal Coliforms

Fecal coliform bacteria have historically been used as indicators of possible waterborne pathogens. These micro-organisms from the gastro-intestinal tracts of warm-blooded animals enter local waterbodies through storm runoff, septic tank seepage, sewer lift station overflows and inadequately-treated sewage effluents. Since they do not multiply readily in the aquatic environment, the number of these bacteria in the water at any given time is directly correlated to the initial concentration and the dieoff rate under ambient environmental conditions. The number of these microbes in a given volume of water (usually 100ml) is used to evaluate the safety of water for municipal water supply, swimming, and shellfish harvesting.

Filter-feeding mollusks, particularly the commercially harvestable oyster, concentrate these waterborne bacteria from the large volumes of water filtered to obtain its organic feed resources. Since the oyster is often consumed raw or without adequate cooking, these shellfish are capable of transmitting diseases (primarily typhoid fever and other Salmonella infections) to humans. In turbid situations, coliforms and other bacteria settle out similar to organic suspended solids and are more available to sessile filter feeders and deposit-feeding benthos at the water-sediment interface. These bacteria have no observed effects upon the resident biota in terms of disease production, and the microbial biomass is utilized directly as an organic food resource by many aquatic organisms. The fear of shellfish contamination by human pathogens is the major inpetus behind water quality criteria for fecal coliforms; therefore, a low value of 14 MPN (most probable number) per 100 ml has been established by EPA Water Quality Criteria for waters suitable for shellfish harvesting. Currently, none of the stream segments in the 208 study area have been designated as shellfish harvesting waters.

The possible ingestion of pathogenic bacteria by a swimmer in waters exhibiting high coliform levels is the primary concern of establishing separate criteria for contact recreation waters. The "swimmable" criteria seeks to insure that human health is protected

TABLE II-C-2

PROPOSED EPA QUALITY STANDARDS FOR INPLACE SEDIMENTS

Volatile Solids	80,000 mg/kg
Chemical Oxygen Demand	50,000 mg/kg
Kjeldahl Nitrogen	1,000 mg/kg
Arsenic	5 mg/kg
Cadmium	2 mg/kg
Chromium	100 mg/kg
Copper	50 mg/kg
Lead	50 mg/kg
Mercury	1 mg/kg
Nickel	50 mg/kg
Zinc	75 mg/kg

from direct transmission of disease while in contact with the water. A level of 200 MPN fecal coliforms/100 ml should lessen the probability of encountering pathogenic bacteria or viruses through direct contact to an acceptable, "safe" level.

Point source discharges from municipal treatment facilities can add significant numbers of coliform bacteria if inadequate chlorination (i.e., chlorine residual too low or contact time too short) of treated effluents is practiced. Local waters sometimes receive untreated sewage discharges bypassed through treatment facilities due to overloaded capacity (i.e., too many people being served or high sewer system infiltration due to rainfall and high water tables) or periodic breakdowns of plant equipment. Nonpoint sources also contribute to the ambient coliform levels by adding both human and domesticated animal wastes. Rainfall events wash such wastes from the land surface and also re-suspend those coliforms at the water-sediment interface in isolated tributary pools and ditches. In addition, areas with large numbers of individual residence septic tank systems and poorly-drained soil conditions may become linked to receiving waters during storm events, and contribute substantially to the high coliform levels noted in the "first flush" runoff phenomena.

Natural Areas

There is currently no widely accepted definition of the term natural area. There are several criteria which can be applied in identifying natural areas and these criteria can be further applied in assessing the importance of an area.

Natural areas within the state have not yet been successfully inventoried although some guidance has been provided for sites within the Texas Coastal Zone. Recognition criteria have been mostly based upon the presence of rare and endangered species, the value of the area as waterfowl habitat, and the value as nursery grounds for estuarine fin and shellfish. Additional criteria could include examples of vegetation and wildlife habitat that still possess primeval characteristics. This insures that an example of formerly widely distributed vegetation types are preserved for future reference. Areas of unique or unusual biota also deserve consideration for designation as a natural area.

Thirty-two natural areas are identified in Table II-G-3 and at least partially described in this report. The locations of these areas are shown in Figure II-G-2. Further field investigation will be required to more thoroughly assess their value as natural areas. A few of the areas included are public lands. Those areas recognized as natural in this report were taken from the Texas Outdoor Recreation Plan and the reports from the Texas Coastal Zone Program of the Texas General Land Office. The map and list contains all areas which have been identified as natural in those publications and which occur in the 208 area. The description following each area has been exerpted from these reports as well as the Harris County Soil Survey and the Coastal Zone Atlas of the Texas Bureau of Economic Geology.

TABLE II-G-3

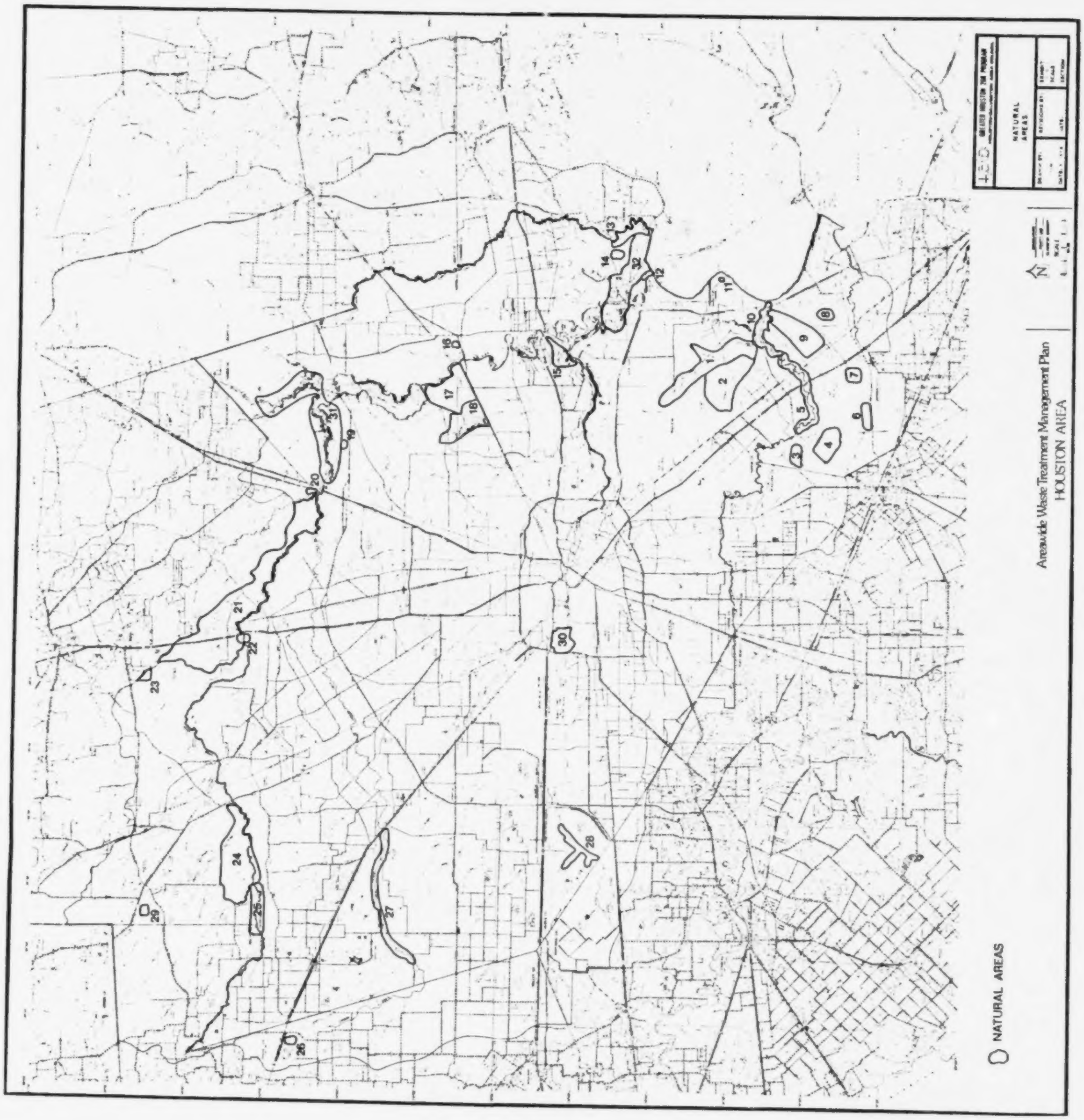
NATURAL AREAS

LEGEND FOR FIGURE II-G-2

1. Armand Bayou and Big Island Slough
2. Headwaters of Horsepen Bayou
3. Cowart Bayou
4. Prairie between Chigger and Magnolia Creek
5. Clear Creek from Clear Lake to Chigger Creek
6. Prairie near Headwaters of Dickinson Bayou
7. Prairie between Magnolia Bayou and Bordens Gully
8. Prairie east of Gum Bayou
9. Prairie adjacent to Jarbo Bayou
10. Seabrook Estuary, Clear Lake, Mud Lake, Taylor Lake
11. Comptons Woods
12. Bird Flats on Morgans Point
13. Forests adjacent to Lower Cedar Bayou
14. Bayton Refinery - Pine Gully Heronry
15. Lost Lake - Lynchburg Ferry Mud Flats and Marshes
16. Jackson Gully Swamp
17. Hardwood Forest below Lake Houston
18. Sheldon Wildlife Management Area
19. Hardwood-Pine Forest south of San Jacinto River
20. San Jacinto River Cypress Pond
21. Spring Creek Bottomlands and Upland Forests

TABLE II-G-3 (CONTINUED)

22. Panther Branch - Spring Creek Bottomland Forest
23. Goodrich Jones State Forest
24. Spring Creek, Walnut Creek, and Three Mile Creek Gallery Forests
25. Spring Creek Gallery Forest
26. Mount Creek Rookery
27. Cypress Creek Gallery Forest
28. Barker Reservoir - Upper Buffalo Bayou
29. Rosehill Pines - Mink Creek Forests
30. Houston Memorial Park
31. Lake Houston Alligator Habitat
32. Cedar Bayou and Tabbs Bay Nursery Area


GREATER HOUSTON 208 PROGRAM
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SCALE

NATURAL AREAS

Areawide Waste Treatment Management Plan
HOUSTON AREA

NATURAL AREAS

II-G-22

Area 1: Armand Bayou and Big Island Slough. Armand Bayou is one of the few remaining natural bayous in the Houston-Galveston area. Three distinct vegatation types exist within this watershed: coastal marshes, prairies and southern evergreen forest. The area possesses a wide variety of plant species and an interesting combination of birds.

Big Island Slough has been channelized and the lower coastal marshes eliminated. Large sections of forest still remain along this slough and provides the reason it is included here. These forests and adjacent prairies provide excellent habitat for deer. Attwater's Prairie Chicken may habitate the prairies west of Armand Bayou. The Bottomlands support large populations of both gray and fox squirrels.

The Armand Bayou area has been identified in the Texas Outdoor Recreation Plan as the most important natural urban area in the state. Harris County has recently acquired a 400 acre tract in the Armand Bayou.

Area 2: Headwaters of Horsepen Bayou. Horsepen Bayou and a northern tributary drain a prairie east of Ellington Air Force Base. This prairie is still in a relatively primitive condition having been previously used as rangeland. The area supports abundant waterfowl and upland game including deer. The area is a known habitat for Attwater's Prairie Chickens.

Area 3: Cowart Bayou and Adjacent Prairies. A large prairie lies on either side of Cowart Bayou in northern Galveston county and within the city limits of Friendswood. This area is currently used for rangeland. Habitat is provided for waterfowl and possibly Attwater's Prairie Chicken.

Area 4: Prairie Between Magnolia Creek and Chigger Creek. This prairie is located within the city limits of Friendswood and League City. Attwater's Prairie Chicken is reported inhabiting this site.

Area 5: Clear Creek from Clear Lake to Chigger Creek. Clear Creek is the inland appendage of the Clear Lake Estuary System and provides nursery areas for menhaden, shrimp and blue crab. Adjacent bottomland forests extend along this creek for approximately 15 miles and provide habitat for deer, squirrels and a large number of birds. Residential development and improper sewage treatment threaten both the aquatic and terrestrial portions of this area.

Area 6: Prairie Adjacent to Dickinson Bayou. This prairie lies just south of Friendswood and between Dickinson Bayou and the headwaters of Magnolia Bayou. The area is currently used for range land. Attwater's Prairie Chicken has been observed here.

Area 7: Prairie Adjacent to Magnolia Bayou and Borden Gully. This area is similar to the preceding prairies and observations of Attwater's Prairie Chickens have been made here.

Area 8: Gum Bayou Prairie. This small prairie is located immediately north and adjacent to Dickinson, Texas in Galveston, County. The area is included here because of reports of Attwater's Prairie Chickens.

Area 9: Jarbo Bayou Prairie. This prairie habitat is in Galveston County, east and north of Dickinson from the city limits and extends to Clear Lake Shores and League City. Habitat is provided for Attwater's Prairie Chicken. This area is significant enough to warrant inclusion as a high priority Urban Natural Area in the Texas Outdoor Recreation Plan.

Area 10: Seabrook Estuary and Clear Lake. This coastal estuary and inland lake are currently the site of active residential development and the maintenance of a natural condition is doubtful. Inadequate sewage treatment and destruction of the fringe marshes has led to an increase in biological oxygen demand with resultant depressed dissolved oxygen levels. Channelization of tributaries leading to Clear Lake and increased development of the area will possibly result in degradation of current environmental quality.

This area functions as a nursery for marine fin and shellfish and is currently used for limited sportsfishing and crabbing.

Area 11: Comptons Woods. This natural area consists of a 12 acre wooded area that is habitat for small game and birds. It is located adjacent to El Jardin Del Mar.

Area 12: Bird Flats on Morgan's Point. Bird Flats is a well known birding site in Harris County. It is located at the eastern edge of the city limits of Morgan's Point on San Jacinto Bay. The site of interest can be described as a significant salt marsh and tidal flat area which is frequented by various species of shore birds as well as nesting birds. This area is included as an Urban Natural Area in the Texas Outdoor Recreation Plan.

Area 13: Forests Adjacent to Lower Cedar Bayou. This hardwood forest is located along Cedar Bayou from northern Baytown to Tabbs Bay. Lower elevated areas along the bayou support water tolerant hardwoods and a ground layer of palmettos. Higher elevated areas grade into mixed pine and hardwoods. The area supports a dense population of gray (cat) squirrels, deer, and raccoons.

Area 14: Baytown Refinery - Pin Gully Heronry. The oxidation ponds and lagoons of this refinery, located on Pine Gully, provide wetland habitat for egrets, herons and spoonbills.

Area 15: Lost Lake - Lynchburg Ferry Mud Flats and Marshes. This area lies within the San Jacinto River Channel at the confluence of Buffalo Bayou. Spoil islands and natural mud bars support fringe marshes and some swampland vegetation. The area provides habitat and resting area for birds and nursery areas for fin and shellfish.

Area 16: Jackson Gully Swamp. The moist forest is located between Jackson Gully and Barrett, Texas and is adjacent to U. S. Highway 90. This area is characterized by water tolerant hardwood mixed with red maple, mock-orange and wisteria. Adjacent sandpits are being used for garbage and waste oil dumps.

Area 17: Hardwood Forests Below Lake Houston. Extensive hardwood forests developed in the floodplain of the San Jacinto River are located between U. S. Highway 90 and Lake Houston. Areas within these forests maintain a near swamplike vegetation. This area is an important deer and squirrel habitat and furnishes resting sites for predatory birds. Small marshes located near Buckhorn Lake provide habitat for waterfowl. This site is located east of Sheldon Wildlife Management Area. A portion of the site is publicly owned.

Area 18: Sheldon Wildlife Management Area. The area around Sheldon Reservior is publicly owned and maintained as a wildlife area. The site is an important waterfowl habitat.

Area 19: Hardwood Pine Forest South of the San Jacinto River-Lake Houston. This area is contained within the large forest system extending along the southern edge of the San Jacinto River. This specific site contains red bay and swamp chestnut trees.

Area 20: San Jacinto River Cypress Pond. This natural swampland is located west of U. S. Highway 59 and adjacent to the West Fork of the San Jacinto River. The site is located in the city limits of Humble. This area is reported to contain the extreme western stand of mock-orange. Also found in this swamp are black walnuts and swamp chestnuts.

Area 21: Spring Creek Bottomlands and Upland Forests. This extensive forested area is located north of Spring Creek and extends from the West Fork of the San Jacinto River to Goodrich Jones

State Forest. This large tract of forest is fair habitat for gray and fox squirrels and deer. Less disturbed areas may support populations of the Red Cockadded Woodpecker, a federally protected endangered species.

Area 22: Spring Creek Bottomland Forest. This small area within the Spring Creek Bottomland is notable for the occurrence of river birch trees.

Area 23: Goodrich Jones State Forest. This State Forest is part of the Texas A&M University System. The forest is managed for both public recreation and forestry education. The area includes nesting sites of the Red Cockadded Woodpecker.

Area 24: Spring Creek, Walnut Creek, and Three Mile Creek Gallery Forests. This floodplain forest is located in the northwestern portion of the HGAC area. The coastal shortgrass prairies are located south of these forests and Hardwood Pine forests occur to the north. The area supports populations of deer and a variety of birds. This site is interesting also in that it is adjacent to areas which are devoid of coastal and marine influences. The Post Oak Savannah begins just northwest of this area.

Area 25: Spring Creek Gallery Forest. This area is adjacent to Area 24 and has similar characteristics.

Area 26: Mound Creek Rookery. This small wet prairie lies just north of Mound Creek in Waller County. White and Glossy Ibis, egrets and herons are reported to nest at this site.

Area 27: Cypress Creek Gallery Forest. This area is located on either side of Cypress Creek and extends west from U. S. Highway 290 to the Harris County line. The regions to the north and south of this creek are important rice growing areas and major habitats for waterfowl. The forest has been partially cleared and portions of Cypress Creek have been channelized. The site is reported to be a wintering area for the Southern Bald Eagle, a federally protected endangered species.

Area 28: Barker Reservoir - Upper Buffalo Bayou. Barker and Addicks Reservoirs are flood control structures located near the headwaters of Buffalo Bayou. The forests adjacent to the stream channel are located within the designated pool area. Addicks Reservoir has been designated as a recreation area. Barker Reservoir has been set aside for wildlife habitat and governmental management should permit the maintainance of this natural area. The bottomlands of Addicks Reservoir have been given a high priority as an Urban Natural Area by the Texas Outdoor Recreation Plan.

The area is a refuge for many birds and small animals.

Area 29: Rosehill Pines. This natural area is located north of Walnut Creek in Montgomery County. This predominantly virgin loblolly pine forest consists of southern red oak, willow oak, swamp white oak and post oak. Many pines reach over 100 feet tall and are reported to be 150 to 200 years old. No timber harvesting has been done in at least fifty years. A small creek with pinkish-white sand bars flows through this site. This area is designated a significant rural natural area in the Texas Outdoor Recreation Plan.

Area 30: Houston Memorial Park. This large public park is included in this list as it maintains a large section of relatively natural area. This park is located on Buffalo Bayou in western Houston. The park provides wildlife habitat for a variety of birds and is considered an excellent area for bird watching.

Area 31: Lake Houston Alligator Habitat. Both the East and West Forks of the San Jacinto River where they intersect Lake Houston are known habitats for the American Alligator. This reptile is federally protected as a threatened species in Texas. These habitats are the major areas supporting this alligator, although sporadic reports of observation are made within the San Jacinto River Basin.

Area 32: Cedar Bayou and Tabbs Bay Nursery Area. This estuarine habitat is the largest nursery area located in the area. Pollutants entering this area from Buffalo Bayou have decreased the area's potential productivity. Dredging activities and spoil disposal have aggravated this situation. The increased restrictions on aquatic pollution and dredging will increase the value of this site as a nursery area.

Endangered Organisms

Rare, endangered or threatened organisms potentially occurring in or near the 208 area have been identified from federal, state, and unofficial lists. Lists of these organisms are included in Tables II-G-4 and II-G-5. The problem of preserving these species within the 208 area is intimately related to the preservation of natural areas. The majority of plant taxa recognized as endangered are endemic to natural habitats and are sensitive to any environmental impact. Any alternation of their preferred habitat will increase the prospect of their ultimate extinction. The situation for endangered animals is similar and may differ in small degrees for migratory birds and waterfowl. These animals follow specific flyways and require at least "islands" of natural habitat throughout their migratory pattern.

TABLE II-G-4

FEDERALLY PROTECTED, ENDANGERED ANIMALS WHICH MAY OCCUR IN 208 STUDY AREA

American Alligator	Common in marshlands, bayous, and river bottoms.
Attwater's Prairie Chicken	Coastal Prairies - especially prairies adjacent to Clear Lake
Arctic Peregrine Falcon	Migratory to coastal habitats
American Ivory Billed Woodpecker	Mature Pine Forests - probably extinct
Eastern Brown Pelican	Nests on Spoil Islands in estuarine areas
Eskimo Curlew	Migratory. Last Texas observation, Galveston Island, 1966.
Red Cockadded Woodpecker	Mature Pine Forests
Red Wolf	Prairies and marshlands
Southern Bald Eagle	Nests in densely forested bottomland forests
Houston Toad	Pine Forest north and west of Houston
Bachman's Warbler	Reported to have been sighted in East Texas Timber Region

TABLE II-G-5

RARE AND ENDANGERED PLANTS

WHICH MAY BE FOUND IN THE 208 STUDY AREA

Common Name	Scientific Name	State Range
Quillwort	Isoetes melanopoda	Eastern half of Texas
Broad beech fern	Thelypteris hexagonoptera	Timber belt of east Texas
Finger grass	Chloris texensis	Coastal prairies, Rio Grande plains
Beak-rush	Rhynchospora macra	Eastern Texas
Beak-rush	Rhynchospora filifolia	Eastern Texas
Sedge	Carex gigantea	Eastern and southeastern Texas
Sedge	Carex stricta	Eastern Texas
Sedge	Carex physorhyncha	Eastern, southeastern, and north-central Texas
Sedge	Carex atlantica	Eastern and southeastern Texas
White sheath sedge	Carex hyalina	Eastern Texas
Wingseed	Carex alata	Eastern Texas
Sedge	Carex albolutescens	Eastern and southeastern Texas
Bush palmetto	Sabal minor	Eastern Texas, west to Edwards Plateau and south to Aransas County
Yellow sunny-bell	Schoendirion texanum	Western edge of southeastern Texas
Yellow sunny-bell	Schoendirion croceum	Southeastern Texas
Dog's tooth-violet	Erythronium rostratum	Eastern Texas
Great Solomon's seal	Polygonatum biflora	Eastern and north-central Texas
Yellow ladys-slipper	Cypridedium calceolus	Eastern Texas
Whorled pogonia	Isotria verticillata	Eastern Texas
Bearded grass-pink	Calopogon barbatus	Eastern Texas
Oval ladies' tresses	Spiranthes ovalis	North-central and east Texas
Corkwood	Leitneria floridana	Southeastern and south-central Texas
Nutmeg-hickory	Carya myristicaeformis	Eastern Texas
Virginia Dutchman's pipe	Aristolochia serpentaria	Edwards Plateau and eastern Texas
Bloodroot	Sanguinaria canadensis	Eastern Texas
Grass-of-Parnassus	Parnassia asarifolia	Eastern Texas
Red chokeberry	Pyrus arbutifolia	Eastern Texas
Silky camellia	Stewartia malacodendron	Eastern Texas
Water-purslane	Peplis diandra	Eastern Texas
Indian-pipe	Montorpa uniflora	Eastern Texas
Shooting-star	Dodecatheon	Eastern third of Texas
Gromwell	Lithospermum tuberosum	Eastern Texas
False foxglove	Aureolavia dispersa	Southeastern Texas
Butterweed	Senecio glabellus	Eastern Texas

The interaction between rare and endangered organisms and water quality conditions must be considered from two levels of impact, i.e., indirect and direct. For example, many predatory organisms concentrate toxic compounds, especially heavy metals and chlorinated hydrocarbons, into their body tissues through normal metabolic processes. These concentrated compounds may have adverse effects indirectly upon the organisms; for instance, DDT concentrations in the body tissues of birds have been shown to result in the production of fragile egg shells.

A much more direct impact of this interaction would result from the loss of preferred habitat. The displaced organisms may not be able to survive in other submarginal habitats and population numbers may decline rapidly. Habitat loss is generally the result of development and alteration of land use. The sensitive ecological areas outlined in the previous section include natural habitats that are largely unaltered. Development of these areas for any purpose will likely have adverse effects on populations of rare and endangered organisms. Extreme caution should be used when planning any construction or land use in these areas.

Projected Future Conditions

Introduction

A principle requirement of a 208 study is an evaluation of environmental conditions that may exist in 1995. The projection of future biological conditions is based on future land use and population projections contained in Chapters II-A and II-B. The elements which are considered in the analysis of future biological conditions are the loss of natural land resources, vegetation and animal habitats that occur in an area where man has had little or no influence, and the substitute land use. Minor man-made alterations of natural areas generally do not result in major significant impacts on the quality of vegetation and wildlife habitat in the affected area. However, major alterations may result in complete loss of vegetation and wildlife populations. The continuity between these extremes is controlled by the manner and extent of man-made alterations.

Projected 1995 Conditions Without Implementation of 208 Plan

The condition of the biologic environment in 1995 will depend heavily upon the distribution of land use types. Previous discussion has indicated that vacant lands and to a lesser degree agricultural and parklands offer the most diverse natural conditions.

If structural control measures are used to control agricultural run-off, these three land use categories will generally not cause significant deterioration of water quality. Thus, biological conditions will strongly depend on the percentage of vacant land, parkland, and agricultural land that occurs in the 208 area. By 1995, the Houston biological environment should not be greatly different from current conditions. The most notable changes will be the approximate doubling of intensively developed land uses. This growth will be concentrated around the periphery of the present Houston corporate area. The northern and western portions of Harris County will be primary development areas.

Growth will place tremendous pressure on the biotic resources of the region. In the future, natural areas with currently undisturbed vegetation and wildlife will be negatively affected by growth. Some of the areas designated in this report as natural areas will change to recreational land use. Unless current trends toward stream channelization are curtailed, many of the bottomland forests will be disturbed. Channelization causes a significant loss of natural biological resources. Serious conflicts will be caused by the proximity of natural biological habitats to developed areas; especially residential development. Elimination of natural areas may be based in part on public health considerations. For instance, natural areas containing aquatic habitats may be considered dangerous to public health because of the potential habitats for mosquitos and poisonous snakes. Assuming that legislated wastewater treatment levels are obtained, water quality conditions gradually improve to meet fishable/swimmable criteria by 1983.

These wastewater treatment goals will probably improve the naturally occuring condition of many of the area streams, especially the water quality which exists during low-flow conditions. Non-point source pollution may still affect surface-water quality unless action is taken to control agricultural and construction run-off.

CHAPTER II-H

Aesthetics - Baseline Characteristics

The aesthetics of the planning area vary from subbasin to watershed and even change within a particular basin. Aesthetics, as defined for this report, deal with the major physical features and are not site specific in nature. Because the plan is basically a management plan and not a site specific recommendation, several key aesthetic features are described by watershed and are considered the major aesthetic features of the area.

Lake Houston Subbasin

Lake Houston vicinity - This upland forest environment is characteristic of the Southern Piney Forest, flat with significant areas of immature drainage, fluctuating understory densities, areas of thickets and scattered small swamps. This mixed hardwood/pine forest provides the aesthetic character of the area which is projected to receive significant amounts of growth and urbanization during the planning period.

Cypress Creek Watershed (Downstream portion) - The creek area from Highway 290 to Lake Houston is characteristic of the gallery hardwood forests as described in the section on Biology. The gallery forest entwines its way along the creek bottom in the midst of upland prairies. In the flat topography of the area the gallery forest provides the only relief along the horizon.

Cypress Creek Watershed (Upstream portion) - The area is characterized by the flat prairie land, with a very thin gallery forest along the stream beds, however, this area is a flat prairie with poor internal drainage. The vast "openness" of the area is in direct contrast to the "closed" nature of the upland forest areas, but is a more typical area in the Greater Houston study area.

Spring Creek Watershed - This upland forest with bottom land hardwoods, is similar in nature to the Lake Houston forests but with more topographic relief and thus better drainage. Thus, the understory is more characteristic of the thicket type forests - very thick and dense.

Houston Ship Channel Subbasin

Houston Ship Channel - This urban/industrial complex dominates the flat, open, former prairie land and now only a few areas of open land exist. The area should be classified as industrial and is a man-made aesthetic environment.

Buffalo Bayou (Allens landing to Addicks reservoir) - This now basically urban bottom land hardwood area is classified as a modified forest. The basic aesthetic feature of the area is the forest that has been saved and exists throughout this reach. Much of the area adjacent to the stream has been retained in a relatively natural state and is considered to be one of the unique scenic and aesthetic features of the area.

Buffalo Bayou (Addicks Reservoir West) - Typically, this section is flat prairie land with sporadic bottom land forests. Much of the area is typically flat rice land that currently is under major development. The flatness of the area also gives a vastness or openness, which often results in a contridiction of watershed boundaries in terms of location. Most of the defined drainage in the area is man-made.

Clear Lake Subbasin

Armand Bayou Watershed - This coastal prairie watershed has a unique range of characteristics. In the southern portion of the watershed exists the meandering sloughs and bayous with their affiliated vegetation. The northern portion of the watershed is characterized by the flat open prairie.

Clear Creek Watershed - This is another open prairie with bottom land forests running along with the creek, causing the rangeland prairie to be bisected with a narrow greenbelt.

Dickinson Bayou Watershed - A coastal prairie situation that is very similar in character to the Clear Creek watershed.

CHAPTER II-I
ARCHEOLOGY

In the greater Houston Area, numerous archeological sites do exist. The identification of these sites has been performed by the Texas Archeological Research Laboratory at the University of Texas. Some 415 sites have been recorded, both amateur and professional. Intentionally these sites have not been mapped as to their specific location. This is because the greatest impact to archeological sites would be the actual site identification, thus allowing the general public to search and sieze the artifacts. Thus only general areas are indicated and have been mapped on Figure II-I-1 and are described as follows:

Clear Lake, Clear Creek and Armand Bayou

Tabbs Bay to Interstate 10, along the banks east and west sides

Galena Park Area

Hunters Creek Village to Addicks and Barker reservoirs vicinity

Cypress Creek from State Highway 59 to Highway 290, both sides of the Creek

North of Tomball - North of Spring Creek

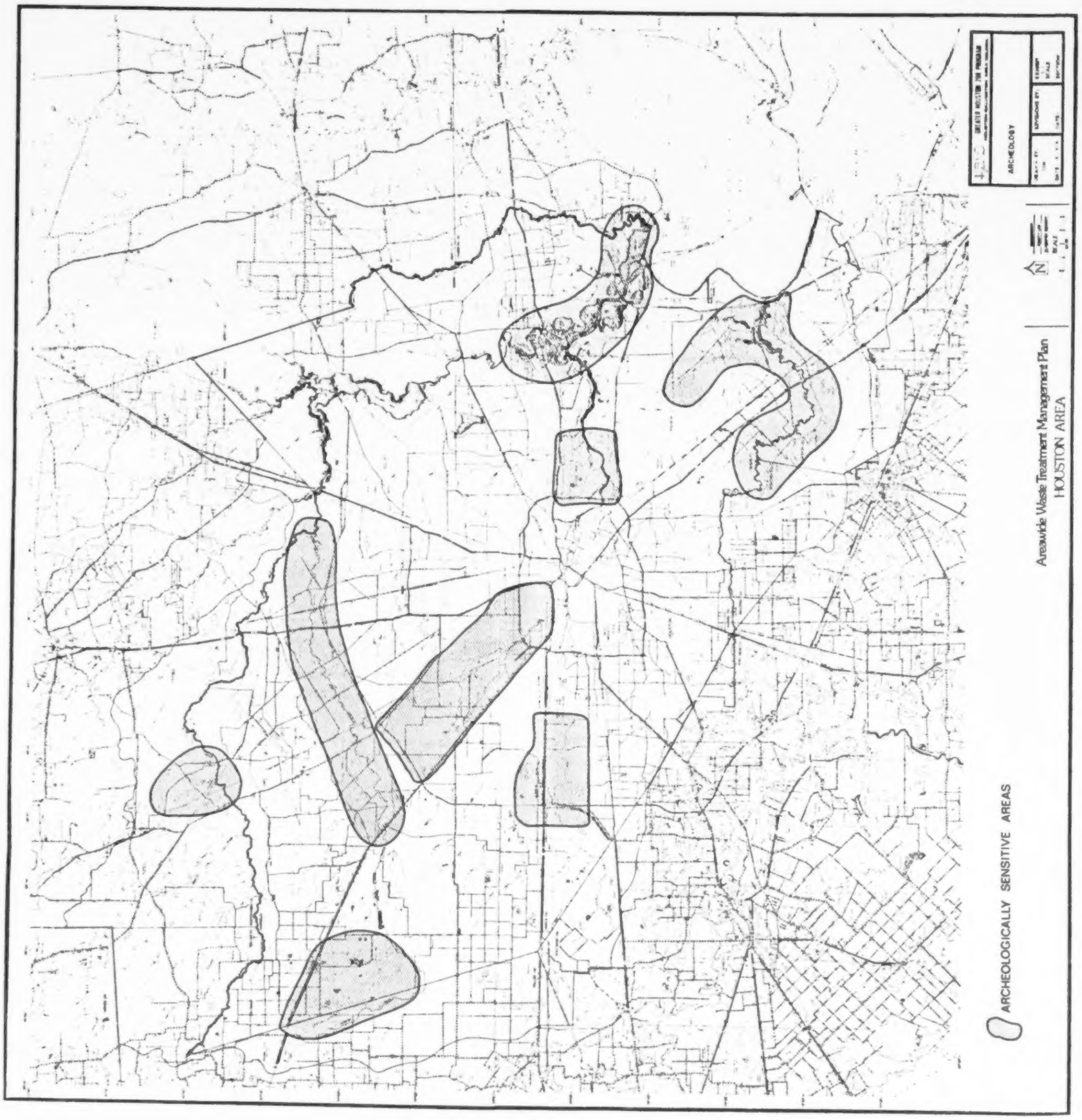
Uppermost reaches of Cypress Creek

Total By County

Harris	377	Galveston	31
Brazoria	4	Montgomery	3

Impact

With or without the plan, archeological sites are site specific and can be identified. The Houston Galveston Area Council has this list and the records are available to determine whether or not future actions are in fact impacting a particular site. But, it should also be noted that five of the areas identified are the same as the zones of greatest change and growth. Potentially, these five areas could be impacted significantly and occur in all three planning areas.


ARCHEOLOGICALLY SENSITIVE AREAS
Areawide Waste Treatment Management Plan
HOUSTON AREA
N
GREATER HOUSTON 208 PROGRAM
ARCHEOLOGY

CHAPTER III
DESCRIPTION OF PLAN ALTERNATIVES AND RECOMMENDATION

Introduction

The following description of Plan Alternatives is but a brief description of nine detailed analyses contained in the "Alternative Technical Subplans" report prepared for the Houston-Galveston Area Council.

Lake Houston and Tributaries-Spring Creek

Analysis of Themes

The water quality projections, based on simulation modeling techniques, for Spring Creek, meet or exceed the fishable/swimmable criteria of Water Quality Level III, except for a five mile section of the stream where the projected dissolved oxygen concentration falls below 5.0 mg/l to 4.8 mg/l. This oxygen deficit based on the projected 1995 wasteloads is considered within the accuracy of the modeling process. Therefore, Spring Creek meets the desired water quality and requires no further analysis.

Findings:

Dry Weather

-Will meet goal of fishable/swimmable quality at existing permit levels with proper operation and maintenance.
-D.O. levels in stream extremely sensitive to NH_3-N discharges of concentrations greater than 8 mg/l.
-Anticipated water quality will produce no detrimental effects in Lake Houston.
-Nonpoint source wasteloads not a significant problem.

Wet Weather

Unverified stormwater model predicts conformance with dry weather standards.

Major Alternatives Considered

Description:	Comment:
Operation of existing and future facilities at current permitted levels with no regionalization.	Meets fishable/swimmable.
Operation of existing and future facilities at current permitted levels with regionalization.	Localized D.O. problems caused by major discharges.

Recommendations:

Dry Weather

- Operate existing and future wastewater treatment facilities at existing permit levels.
- Keep alert to regional wastewater treatment opportunities if warranted by future population patterns.
- Implement monitoring program to update and verify dry weather model.
- Consider adopting effluent standard of 8 mg/l of NH_3-N for use in permits where more restrictive levels do not presently apply.
- Maximum limits on chlorine residual in plant effluents should be considered by Texas Department of Water Resources.

Wet Weather

- Implement monitoring program to update and verify wet weather model.
- Formulate wet weather standards consistent with fishable/swimmable goal.
- Encourage use of best management practices to reduce amount of pollutants washed to stream.

Costs:

- Those necessary to meet existing permit levels.
- Potential increased costs for NH_3-N reduction and chlorination control.
- Sampling and analytical work to update and verify models.

Cypress Creek

Analysis of Themes:

Several wasteload control themes are available to meet the desired water quality goal as specified in the segment analysis.

Findings:

Dry Weather

- Dissolved oxygen levels projected to fall below goal of fishable/swimmable quality.
- Fecal coliform levels projected to meet goal of fishable/swimmable quality.
- Nonpoint source wasteloads in the form of benthic oxygen demand are a major problem in the lower portion of the Creek.
- At a minimum, benthal loads must be reduced by 2/3 to meet water quality standards.
- Nutrients do not present a problem in this segment.

D.O. levels as low as 3.0 mg/l and BOD levels of 10 mg/l at the mouth of
- Cypress Creek have no adverse effect upon Spring Creek or Lake Houston.

Wet Weather

- Unverified stormwater model predicts conformance with dry weather standards.

Major Alternatives Considered:

Description:	Comment:
Operate existing and future facilities at current permit levels.	Does not meet fishable/swimmable.
Upgrade treatment efficiency to 5/mg/1 BOD, 5 mg/1 TSS, 3 mg/1 NH_3-N plus post-aeration (4NA).	With 2/3 reduction of benthal load meets fishable/swimmable.
Transport certain plant effluents at Level 2 (10 mg/1 BOD, 15 mg/1 TSS) to Greens Bayou; upgrade remaining plants to 4NA).	Meets fishable/swimmable with 2/3 reduction of benthal load. Potential savings of $2 million as compared to all plants at 4NA.

Recommendations:

Dry Weather

- Operate existing and future wastewater treatment facilities at current permit levels pending outcome of benthal load studies.
- Construct future facilities with provisions to meet 4NA requirement.
- Actively pursue opportunities for regional wastewater treatment.
- Initiate field studies to assess (1) actual benthal demand along the Creek, (2) relationship between level of sewage treatment and benthal load, and (3) verify steady state model.
- Maximum limits on chlorine residual in plant effluents should be considered by Texas Department of Water Resources.
- Implement strong enforcement policy to ensure permit compliance.

Wet Weather

- Implement monitoring program to update and verify wet weather model.
- Formulate wet weather standards consistent with fishable/swimmable goal.
- Encourage use of best management practices to reduce amount of pollutants to stream.
- Closely coordinate with flood control projects, particularly as related to water quality impacts and implementation of nonstructural controls.

Costs:

Potential cost savings of $13 million (present worth) exist for the development of regional wastewater treatment facilities within this basin over the next 20 years. Actual cost savings can only be determined on an individual service area basis during implementation.

Potential increased costs for chlorination control.

Sampling and analytical work to update and verify models.

Sampling and analytical work related to study of benthal loads.

Lake Houston

Analysis of Themes

The water quality in Lake Houston is projected to meet or exceed Water Quality Level III, the fishable/swimmable goals. Therefore, only nutrient loadings remain as a potential problem and are considered in the development of control themes.

Findings:

Dry Weather

- Will meet goal of fishable/swimmable quality at existing permit levels with proper operation and maintenance; fecal coliform concentrations projected to remain less than 20 MPN/100 ml.
- Nonpoint source wasteloads not a significant oxygen demand problem.
- Eutrophication may be a problem.
- The above findings are based on population projections which are lower than recent trends suggest.

Wet Weather

- Phosphorous loads contributed from outside the designated 208 area exceed by nearly 6 times the load at which eutrophication problems could arise and nearly 4 times the load contributed from within the designated 208 area.

Costs:

Potential cost savings of $13 million (present worth) exist for the development of regional wastewater treatment facilities within this basin over the next 20 years. Actual cost savings can only be determined on an individual service area basis during implementation.
Potential increased costs for chlorination control.
Sampling and analytical work to update and verify models.
Sampling and analytical work related to study of benthal loads.

Clear Creek/Clear Lake

Introduction

The Clear Creek/Clear Lake technical subplanning area is located in the southeast quadrant of the 208 planning area (see Exhibit IV-1). The area has experienced major development in the last five years and is projected to continue this trend throughout the planning period. The water courses of concern in this area include Clear Creek (both tidal and nontidal portions), Clear Lake, Dickinson Bayou (both tidal and nontidal portions), and Armand Bayou.

Clear Creek Nontidal

Analysis of Themes

Several wasteload control themes are avilable to meet the desired water quality as specified in the segment analysis. The themes analyzed and their rejection or acceptance for additional study is presented below.

Findings:

Dry Weather
- Dissolved oxygen levels projected to fall below goal of fishable/swimmable quality.
- Fecal coliform levels projected to meet goal of fishable/swimmable.
- Nonpoint source wasteloads not a significant problem.
- Nutrient loads do not affect water quality in this segment but comprise a portion of the total load entering Clear Lake.

Wet Weather
- Based on unverified stormwater model, wet weather pollution is a problem in Clear Creek.
- Dissolved oxygen concentrations drop to low levels within the 1983-1990 time frame.
- Fecal coliform concentrations become excessive between present time and 1983; high concentrations linger 11-12 days after storm.

50-75% reduction in BOD needed by 1995 to protect fishable/swimmable uses.

Major Alternatives Considered:

Dry Weather:	Comment:
Operate existing and future municipal treatment facilities at current permit levels.	Does not meet fishable/swimmable.
Upgrade treatment efficiency to 5 mg/l BOD, 5 mg/l TSS, 3 mg/l NH_3-N, 1 mg/l P plus postaeration (effluent set 4 NPA).	Approaches fishable/swimmable.
Upgrade treatment efficiency to 4 NPA with land disposal.	Meets fishable/swimmable.
Transport certain plant effluents at Level 2 (10 mg/l BOD, 15 mg/l TSS) to Houston Ship Channel; upgrade remaining plants to 4 NPA.	Meets fishable/swimmable; potential economic incentives; political feasibility in question.

Dry Weather:	Comment:
Remove phosphorous controls in all alternatives considered.	Cost/benefit of phosphorous control in question.
Wet Weather	
Immediate implementation of nonstructural controls.	Unreliable data base to support firm recommendations.
Develop test areas to monitor effectiveness of nonstructural controls.	Allow for development of reliable data base.

Recommendations:

Dry weather

- Eliminate phosphorous removal requirements; reinstate if Clear Lake eutrophication study shows need.
- Evaluate interbasin transport of major municipal wasteloads (at effluent set 2) to Houston Ship Channel watershed in order to achieve economic advantages and fishable/swimmable quality.
- If interbasin transport not feasible, upgrade and operate existing facilities at effluent set 4 NA and drop dissolved oxygen standard to 4.5 mg/l.
- Institute a monitoring program to update and verify dry weather model.
- Maximum limits on chlorine residuals in plant effluents should be considered by Texas Department of Water Resources.
- Implement a strong enforcement policy to ensure permit compliance.

Wet Weather

- Calibrate and verify wet weather model inputs and response.
- Select and develop test areas to monitor the effectiveness of nonstructural controls.
- If verified models confirm potential water quality problems:
    (1) Expand test area program.
    (2) Reserve sufficient land to implement nonstructural controls.
    (3) Based on test area results, implement most satisfactory nonstructural controls.
- Closely coordinate with flood control projects, particularly as related to water quality impacts and implementation of nonstructural controls.
- Encourage best management practices to reduce amount of pollutants to stream.
- Formulate wet weather standards consistent with goal of fishable/swimmable quality.

Costs:

Potential cost savings of $4.5 million with implementation of interbasin transport and upgrading remaining discharges to 4 NA when compared with upgrading all discharges to 4 NA with no interbasin transport.
Potential cost savings with removal of phosphorous controls (see Clear Lake Costs).

Those associated with updating and verification of dry weather model and calibration and verification of wet weather model.
Potential increased costs of chlorination control.

Clear Creek Tidal

Analysis of Themes

Since the water quality projections for 1995 meet or exceed the fishable/swimmable criteria of water quality level III, except during dredging activities, and since further control of nutrients was rejected as a control theme (as presented in the Clear Lake section), Clear Creek tidal segment requires no further analysis. The only theme (Theme 1) to be evaluated is as follows:

Findings:

Dry Weather
- Will meet goal of fishable/swimmable quality at current permit levels with proper operation and maintenance.
- Nonpoint source loads, other than dredging operations, are not a significant problem.
- Dredging operations, every three years for 3-month duration, contribute an additional 1,800 lb/day BOD as well as high concentrations of suspended solids.
- Nutrient loads do not affect water quality in this segment but comprise a portion of the total load entering Clear Lake.

Wet Weather
- Stormwater simulation model has not been developed for this segment.
- Water quality may reflect that evidenced in the Clear Creek nontidal segment due to similar land uses and growth patterns.

Major Alternatives Considered:

Dry Weather:	Comments:
Operate existing and future municipal wastewater treatment facilities at current permit levels.	Meets fishable/swimmable.
Operate existing and future municipal wastewater treatment facilities at current permit levels, removing phosphorous controls.	Cost/benefit of phosphorous control in question.

Wet Weather
- Please refer to write-up for Clear Creek (nontidal);

Recommendations:

Dry Weather
Eliminate phosphorous removal requirements; reinstate if Clear Lake eutrophication study shows need.
Operate existing and future municipal wastewater treatment facilities at 5 mg/l BOD, 12 mg/l TSS, 5 mg/l NH_3-N as monthly averages.
Dredging activities should be prohibited during critical dry weather conditions.
Maximum limits on chlorine residual in plant effluents should be considered by Texas Department of Water Resources.

Wet Weather
Evaluate problems and potential solutions in conjunction with recommendations for nontidal portion.
Encourage use of best management practices to reduce the amount of pollutants to the stream.

Costs:

Those necessary to meet current permit levels without phosphorous controls.
Potential savings for removal of phosphorous controls (see Clear Lake costs).
Potential increased cost for chlorination control.
Sampling and analytical work to determine if wet weather water quality parallels that predicted for nontidal segment.

Clear Lake

Analysis of Themes

The water quality in Clear Lake is projected to meet or exceed Water Qualtiy Level III, the fishable/swimmable goals, except during dredging activities. Therefore, only nutrient loadings remain as a potential problem and are considered in the development of themes.

Findings:

Dry Weather

-Will meet goal of fishable/swimmable quality at current permit levels with proper operation and maintenance.
-redging operations add 1,800 lbs per day BOD plus high TSS concentrations; dredging activity is infrequent.
Other than dredging operations, nonpoint source wasteloads pose no significant oxygen demand problem.

Wet Weather

- Wet weather simulation model has not been developed for this segment.
- Water quality may reflect that evidenced in Clear Creek nontidal segment due to similar land uses and growth patterns.
- Nutrient loads are estimated to be about 20 times the load at which eutrophication problems could arise.

Major Alternatives Considered:

Description:	Comment:
Operate existing and future municipal wastewater treatment facilities at current permit levels.	Meets fishable/swimmable.
Drop phosphorous controls over entire watershed for existing and future facilities.	Cost/benefit of phosphorous removal in question.
Increase phosphorous controls over entire watershed for existing and future facilities.	Phosphorous load decrease insignificant.

Recommendations:

Dry Weather
- Operate existing and future municipal wastewater treatment facilities at 5 mg/1 BOD, 12 mg/1 TSS, 5 mg/1 NH_3-N, as monthly averages (modified effluent set 3N).
- Eliminate phosphorous controls; reinstate if eutrophication study shows need.
- Prohibit dredging operations during critical dry weather conditions.
- Maximum limits on chlorine residuals in plant effluents should be considered by Texas Department of Water Resources.

Wet Weather
- Initiate wet weather water quality monitoring program to determine if any similarities exist with predicted quality in the Clear Creek Nontidal segment.
- Formulate wet weather standards consistent with fishable/swimmable goal.

Costs:

- Those needed to meet current permit levels without phosphorous controls.
- Potential cost savings to the entire Clear Lake Watershed of $6 million, with removal of phosphorous controls.
- Those associated with eutrophication studies.
- Those associated with wet weather water quality monitoring program.

Armand Bayou

Analysis of Themes

Several wasteload control themes are available to meet the desired water quality as specified in the segment analysis. The themes analyzed and their rejection or acceptance for additional study is presented below:

Findings:

Dry Weather

- Findings dependent on accuracy of simplified, nonspecific stream model.
- Dissolved oxygen levels projected to fall below goal of fishable/swimmable.
- Fecal coliform level will meet goal of fishable/swimmable.

Nutrient loadings present no water quality problem in this segment, but comprise a portion of the loading to Clear Lake.

Wet Weather

There is no existing wet weather model for this segment.

Major Alternatives Considered:

Description:	Comment:
Operate existing and future municipal wastewater treatment facilities at current permit levels.	Does not meet fishable/swimmable according to simplified model.
Utilize interbasin transport of major discharges.	Meets fishable/swimmable; political feasibility in question.
Remove phosphorous controls.	Cost/benefit of phosphorous controls in question.

Recommendations:

Dry Weather

- Operate existing and future municipal wastewater treatment facilities at 5 mg/l BOD, 12 mg/l TSS, 5 mg/l NH_3-N as monthly averages (modified effluent set 3 N).
- Drop phosphorous controls; reinstate if Clear Lake eutrophication study shows need.
- Institute a water quality monitoring program to develop a calibrated/verified model.
- Maximum limits on chlorine residuals in plant effluents should be considered by Texas Department of Water Resources.

Wet Weather

-Institute a wet weather water quality monitoring program to determine if water quality problems exist similar to Clear Creek nontidal.

Costs:

-Those needed to meet current permit levels without phosphorous controls.

-Potential cost savings for removal of phosphorous controls (see Clear Lake Costs).

-Those associated with monitoring programs to develop dry weather model and determine wet weather water quality.

-Potential increased costs for chlorination controls.

Dickinson Bayou

Analysis of Themes

Several wasteload control themes are available to meet the desired water quality as specified in the segment analysis.

Findings:

Dry Weather

-Based on nonspecific water quality model, DO concentrations approach fishable/swimmable.

-Fecal coliform concentrations will meet fishable/swimmable.

-Nonpoint source wasteloads present no water quality problem in this segment.

-Nutrient wasteloads present no water quality problem in this segment.

Major Alternatives Considered:

Description:	Comment:
Operate existing future municipal wastewater treatment facilities at current permit level.	Approaches fishable/swimmable.
Upgrade existing level of treatment to 10 mg/l BOD, 15 mg/l TSS as monthly averages (effluent set 2).	Meets fishable/swimmable.

Recommendations:

Dry Weather

-Operate existing municipal wastewater treatment facilities at current permit level (effluent set 1).

-Upgrade level of municipal wastewater treatment to effluent set 2 prior to 1995 as required by increased wasteloads.

-Extend verified model recommended for tidal segment to include nontidal segment.
-Maximum limits on chlorine residual in plant effluents should be considered by Texas Department of Water Resources.
-Consider adopting standard of 8 mg/l of NH_3-N for use in permits where more restrictive levels do not apply.

Wet Weather
-Institute a wet weather water quality monitoring program.

Costs:

-Those necessary to operate and maintain municipal wastewater treatment facilities at effluent set 1.
-Those necessary to upgrade municipal wastewater treatment facilities to effluent set 2 by 1995.
-Those associated with extending a verified (dry weather) water quality model to include the nontidal segment.

Dickinson Bayou Tidal

Findings:

Dry Weather
-Based on a nonspecific water quality model, dissolved oxygen concentrations will not meet fishable/swimmable.
-Fecal coliform concentrations will meet fishable/swimmable.
-Nutrient loads present no water quality problem in this segment.
-DO concentrations in stream sensitive to NH_3-N discharges of concentrations greater than 8 mg/l.

Wet Weather
-There is no stormwater model for this segment.

Major Alternatives Considered:

Description:	Comment:
Operate existing and future municipal wastewater treatment facilities at current permit levels.	Does not meet fishable/swimmable in 1995.
Upgrade existing level of municipal wastewater treatment to 5 mg/l BOD, 10 mg/l TSS, 5 mg/l NH_3-N, 2 mg/l P as monthly averages (effluent set 3 NP).	Meets fishable/swimmable.
Remove phosphorous controls.	Cost benefit of phosphorous controls in question.

Recommendations:

Dry Weather

-Eliminate phosphorous control requirements.

-Operate existing municipal wastewater treatment facilities at 10 mg/l BOD, 15 mg/l TSS (effluent set 2).

-Construct future facilities with the provision for upgrading to 5 mg/l BOD, 10 mg/l TSS, 5 mg/l NH_3-N (effluent set 3N).

Develop a dry weather model to justify upgrading municipal wastewater treatment facilities to effluent set 3N or some other standard.

-Maximum limits on chlorine residual in plant effluents should be considered by Texas Department of Water Resources.

-Consider adopting effluent standard of 8 mg/l of NH_3-N for use in permits where more restrictive levels do not apply.

Wet Weather

-Institute a wet weather water quality monitoring program.

Costs:

-Those necessary to operate and maintain municipal wastewater treatment facilities at effluent set 2.

-Potential increased costs for upgrading facilities to effluent set 3N.

-Those associated with wet weather water quality monitoring program.

-Those associated with the development of a verified dry weather water quality model.

Upper Houston Ship Channel and Tributaries To Confluence with the San Jacinto River

Introduction:

The technical subplan area for the Houston Ship Channel and tributaries of the San Jacinto River is located in the central portion of the 208 planning area. The major waterway within this area is the Houston Ship Channel, a major navigation artery which links the Port of Houston with Galveston Bay. The waterway receives and transports large quantities of waste from the Houston area urban-industrial complex.

In addition to the above sources, wastes are conveyed into the system via numerous tributaries. Significant contributions originate from municipal and industrial plants along Buffalo Bayou, White Oak Bayou, Drays Bayou, Sims Bayou, Hunting Bayou, Vince Bayou, Greens/Hall Bayou, and Carpenter Bayou. For ease of discussion, development of the alternative technical subplans is addressed separately for the Upper Houston Ship Channel and Turning Basin, Buffalo Bayou, and the remaining tributaries.

Houston Ship Channel

Analysis of Themes - Dry Weather. Based on the results of the segment analysis, water quality in the upper reaches of the Houston Ship Channel is dominated by Buffalo Bayou, Sims Bayou, and the defined benthic demand. Therefore, in order to improve the water quality in the upper reaches of the Houston Ship Channel, wasteload reductions in the tributary bayous or supplemental oxygen input to the Ship Channel are required.

Findings.

Dry Weather

- -Water quality of Segment 1007 (Turning Basin) dominated by municipal wasteloads entering through tribuatries.
- -Dissolved oxygen concentrations do not meet fishable/swimmable in Segment 1007, but achieve fishable/swimmable in Segment 1005 and the lower portion of Segment 1006.
- -Fecal coliform concentrations meet fishable/swimmable in all segments.
- -Water quality in all side bays meet fishable/swimmable.
- -Wasteloads entering Segment 1005 have minimal effect on dissolved oxygen profiles of Segments 1006 and 1007.
- -Nonpoint source wasteloads other than dredging and benthal load present no water quality problem.
- -Benthal loads may be significant and are not well defined.
- -Instream aeration offers potential for increasing assimilative capacity of Lower Ship Channel (Segment 1005) while meeting goal of fishable/swimmable.

Wet Weather

- -Unverified stormwater model indicates significant water quality problems during wet weather such that fishable/swimmable in unattainable. This finding does not correlate with recent observations.
- -DO level drops below 1.0 mg/l throughout most of Houston Ship Channel; recovery period is long (at least 10 days); up to 75% BOD reduction to meet goal of fishable/swimmable.

Major Alternatives Considered.

Dry Weather:	Comment:
Operate existing municipal wastewater treatment facilities at current permit levels and existing and future industrial wastewater treatment facilities at Federally-mandated standards.	Does not meet fishable/swimmable for Segment 1007 and upper portion of Segment 1006. Does meet fishable/swimmable for Segment 1005, lower portion of Segment 1006, as well as all side bays.

Dry Weather:	Comment:
Upgrade major municipal facilities contributing to critical dissolved oxygen concentration to effluent set 4N. Operate all others as above.	Same as above.
Operate existing and future municipal and industrial facilities as in first alternative plus instream aeration.	Meets fishable/swimmable.
Wet Weather	
Hold first flush.	Does not meet fishable/swimmable.
Reduce nonpoint source wasteloads 50%.	Does not meet fishable/swimmable.
Reduce nonpoint source wasteloads 75%.	Meets fishable/swimmable. Cost prohibitive.

Recommendations.

Dry Weather

- No new point source controls until it is determined if fishable/swimmable is attainable.
- Verify dry weather model with emphasis on nitrogenous and benthal oxygen demands.
- Expand dry weather model to include all tributaries receiving major wasteloads.
- Actively evaluate instream aeration to obtain additional stream assimilative capacity if fishable/swimmable standards are to be met.

Wet Weather

- Institute a wet weather water quality monitoring program.
- If monitoring indicates fishable/swimmable condition is attainable, develop a verified model for both inputs and response.
- If monitoring indicates fishable/swimmable is unattainable, existing standards should not be changed.

Costs.

- Those needed to operate and maintain existing and future municipal wastewater treatment facilities at current permit levels.
- Those needed to operate and maintain existing and future industrial wastewater treatment facilities at Federally-mandated standards.
- Those associated with dry weather model verification and expansion.

-Those needed to implement a wet weather water quality monitoring program.
-Potential cost for implementation of instream aeration.

Buffalo Bayou

Analysis of Themes. Several wasteload control themes are available to meet the desired water qualtiy as specified in the segment analysis.

Findings.

Dry Weather
-Based on a "nonspecific" model, dissolved oxygen concentration will not meet the goal of fishable/swimmable.
-Fecal coliform concentrations will meet the goal of fishable/swimmable.
-Much public interest has been generated in the over-all condition of this bayou.

Wet Weather
-As indicated by Houston Ship Channel stormwater model, there are no apparent water quality problems in the lower five miles of this bayou.

Recommendations.

Dry Weather
-Classify that section of the bayou between the Turning Basin and Addicks/Barker Dams.
-Determine desired water quality for classified segment consistent with non-contact recreation and preservation of bayou aesthetics.
-Extend Houston Ship Channel model to include Buffalo Bayou up to Barker Dam and determine wasteload allocations consistent with water quality standards.

Wet Weather
-Formulate wet weather standards consistent with non-contact recreational activities.
-Monitor wet weather water quality.
-Utilize modeling efforts currently underway under the direction of the City of Houston Health Department and Rice University.
-Closely coordinate all efforts with flood control projects, particularly as related to water quality impacts and implementation of nonstructural controls.

Other Tributaries of the Houston Ship Channel

Analysis of Themes. Several wasteload control themes are available to meet the desired water qualtiy as specified in the segment analysis.

Findings.

-Fishable/swimmable unattainable for White Oak, Sims, Greens/Halls, and Carpenter Bayous under existing levels of treatment.
-Significant expenditures required to meet fishable/swimmable in Brays, Vince, and Hunting Bayous.

Recommendations.

-Do not classify.
-Attempt to meet facal coliform concentrations of less than 200/MPN/100ml.
-Operate existing and future municipal wastewater treatment facilities at current permit levels.
-Operate existing and future industrial wastewater treatment facilities at Federally-mandated standards.

San Jacinto River (Tidal)
Houston Ship Channel and Adjoining Bays
Confluence with the San Jacinto River to Morgan's Point

Introduction

The San Jacinto technical subplanning area is located along the eastern edge of the 208 planning area (see Exhibit VI-1). The major tidal waterways within this area are the Houston Ship Channel and the San Jacinto River. For ease of discussion, the San Jacinto River and Houston Ship Channel Segments are addressed individually.

Analysis of Themes

Based on simulation modeling techniques and available data, the water quality projections for the lower Houston Ship Channel and Segments 2426, 2427, 2428, 2429, and 2430 meet or exceed fishable/swimmable criteria of Water Quality Level III. Therefore, the lower Houston Ship Channel and its adjoining bays meet the desired water quality and require no further analysis. The only theme to be evaluated is the theme that calls for a continuation of the existing level of technolgoy.

Findings.

Dry Weather

-Will meet goal of fishable/swimmable quality at existing permit levels with proper operation and maintenance.
-Water quality in lower portion dominated by Houston Ship Channel.
-Wasteloads during dredging operations estimated to be 8,600 lbs, BOD/day, which is far in excess of BOD loads from point sources.
-Dry weather model does not consider benthal load.

Wet Weather
-Uncalibrated, unverified stormwater model results indicate non-compliance with dry weather standards only in the lower portion where water quality is influenced by the Houston Ship Channel.

Major Alternatives Considered:

Description:	Comment:
Operate existing and future municipal wastewater treatment facilities at current permit levels with no regionalization.	Meets fishable/swimmable.
Operate existing and future municipal facilities at current permit levels with regionalization.	Meets fishable/swimmable; economic incentives in question.

Recommendations:

Dry Weather
-Operate existing and future municipal wastewater facilities at 10 mg/l BOD, 15 mg/l TSS (effluent set 2).
-Consider adopting effluent standard of 8.0 mg/l of NH_3-N for use in permits where more restrictive levels do not apply.
-Prohibit dredging during critical dry weather conditions.
-Update dry weather model with emphasis on benthal load.
-Monitor water quality to measure impact of Houston Ship Channel.

Wet Weather
-Institute wet weather water quality monitoring program, including measuring the impact of the Houston Ship Channel on the lower portion of this Segment.
-Formulate wet weather standards consistent with fishable/swimmable.

Costs:

-Those needed to operate and maintain municipal wastewater treatment facilities at effluent set 2.
-Those associated with updating the dry weather model.
-Potential increased costs for NH_3-N controls.
-Those associated with dry and wet weather water quality monitoring programs.

CHAPTER IV
DESCRIPTION OF THE RECOMMENDED PLAN

Introduction

In general the summary and recommendations of the recommended plan as contained in the summary report are as follows:

General Recommendations

Findings/recommendations are only as good as input data and analytical tools used (e.g., population/land use projections, wasteload calculations, stream models): KEEP PROGRAM UP-TO-DATE AND RESPONSIVE TO MANAGEMENT SYSTEM AND PUBLIC PARTICIPATION.

For the most part, operation of existing and future plants at current permit levels will result in attainment of "fishable/swimmable" water quality during dry weather conditions: ACTIVELY PROMOTE PROPER OPERATION AND MAINTENANCE OF WASTEWATER TREATMENT FACILITIES.

The preferred approach for progressing toward attainment of clean water goals builds on coordination of existing authorities, economic incentives and sharing of technical expertise: CONTINUE ACTIVE STATE ROLE IN WASTE TREATMENT MANAGEMENT AND ESTABLISH A LOCAL "WATER QUALITY COUNCIL" WITH A CHARTER TO (1) OVERSEE UP-DATE/IMPLEMENTATION OF 208 PROGRAM; (2) SPEARHEAD NONPOINT SOURCE POLLUTION CONTROL EFFORTS; and (3) PROVIDE INPUT TO FEDERAL/STATE AGENCIES ON ACTIONS RELATED TO WATER QUALTIY.

A limited amount of reliable data exists for substantiating the impact of pollutants coming from nonpoint sources: ASSIGN HIGH PRIORITY TO IMPROVING NONPOINT SOURCE DATA BASE, INCLUDING EFFECTIVENESS OF CONTROLS, AND ENCOURAGE LOCAL GOVERNMENT IMPLEMENTATION OF "BEST MANAGEMENT PRACTICES".

Specific standards have not yet been formulated to gauge acceptable water quality during stormwater conditions: WORK WITH FEDERAL/STATE AGENCIES TO FORMULATE WET WEATHER WATER QUALITY STANDARDS.

There is technical merit in addressing water quality problems/actions on a watershed basis: ORGANIZE LOCAL 208 PROGRAM ACCORDING TO THREE PRIMARY WATERSHEDS (1) SPRING CREEK/CYPRESS CREEK/LAKE HOUSTON, (2) CLEAR CREEK/CLEAR LAKE/DICKINSON BAYOU, and (3) HOUSTON SHIP CHANNEL AND TRIBUTARIES. CONSIDER EXPANSION OF DESIGNATED 208 PLANNING AREA TO COMPRISE ENTIRETY OF SAN JACINTO WATERSHED.

Recommendations by Watershed

Spring Creek/Cypress Creek/Lake Houston

Subject to the limitations cited above, Spring Creek and Lake Houston will meet "fishable/swimmable" goal in 1995 during both dry and wet weather conditions at existing levels of treatment.

Cypress Creek evidences a water quality problem during low flow conditions but not during wet weather. MAJOR EFFORTS SHOULD BE FOCUSED ON (1) WATER QUALITY IMPACT OF MATERIALS DEPOSITED ON STREAM BOTTOM (BENTHIC LOAD), (2) TOUGH ENFORCEMENT OF PERMIT CONDITIONS, and (3) CONTINUING ATTEMPTS TO IMPLEMENT JOINT TREATMENT FACILITIES SUPPORTED BY ECONOMIC INCENTIVES.

CLOSELY MONITOR POPULATION GROWTH AND DISTRIBUTION IN THIS WATERSHED.

CONSIDER EXPANSION OF DESIGNATED 208 PLANNING AREA TO INCLUDE OTHER STREAMS ENTERING LAKE HOUSTON (EAST AND WEST FORKS OF SAN JACINTO RIVER, LUCE BAYOU).

Clear Creek/Clear Lake/Dickinson Bayou

Water quality problems exist in this urbanized watershed during both dry and wet weather conditions.

Clear Creek (nontidal) will not meet "fishable/swimmable" at existing, restrictive permit levels: EVALUATE FEASIBILITY OF TRANSPORTING SELECTED DISCHARGES TO HOUSTON SHIP CHANNEL vs. FURTHER UPGRADING OF ALL PLANTS AND LOWERING OF DISSOLVED OXYGEN STANDARD.

Wet Weather conditions in Clear Creek fail to meet "fishable/swimmable" criteria in 1983-1995: VALIDATE WET WEATHER MODEL AND EXAMINE EFFECTIVENESS OF NONPOINT CONTROLS IN TEST AREAS.

Simplified stream models also indicate potential water quality problems in Armand Bayou and Dickinson Bayou (Tidal) during dry weather (there are no stormwater models): VALIDATE DRY WEATHER MODELS AND INSTITUTE WET WEATHER MONITORING PROGRAM.

Phosphorus (nutrient) loads to Clear Lake and Galveston Bay from nonpoint sources and tidal action most likely exceed the minimum level needed for algae problems (eutrophication): ELIMINATE PHOSPHOROUS REMOVAL REQUIREMENTS IN MUNICIPAL DISCHARGE PERMITS UNTIL SUCH TIME THAT A EUTROPHICATION STUDY ON CLEAR LAKE DEMONSTRATES TECHNICAL NEED AND COST EFFECTIVENESS.

Dredging operations, though infrequent, impose a substantial wasteload: PROHIBIT DREDGING OPERATIONS DURING CRITICAL DRY WEATHER CONDITIONS.

CONSIDER EXPANSION OF DESIGNATED 208 PLANNING AREA TO INCLUDE TEXAS CITY/GALVESTON AREA.

Houston Ship Channel, Lower San Jacinto River, and Bayou Tributaries

Except for the turning basin and points immediately downstream, water quality in the Houston Ship Channel is projected to meet "fishable/swimmable" goal during dry weather (following completion of improvement, currently underway, to City of Houston treatment system).

Water quality in all side bays is expected to meet goal during dry weather.

Unverified stormwater model indicates substantial water quality problems throughout the Ship Channel during wet weather conditions; dissolved oxygen drops to zero for a period of days; calculations do not correlate with recent observations (i.e., lack of fish kills): INSTITUTE A WET WEATHER MONITORING PROGRAM TO DETERMINE ACTUAL CONDITION OF CHANNEL DURING STORMS PRIOR TO RECOMMENDING FURTHER SPECIFIC ACTION ON STANDARDS, MODELS, OR CONTROLS.

Supplemental in-stream aeration offers potential for low cost attainment of "fishable/swimmable" goal in upper reaches of channel (dry weather): EVALUATE IN-STREAM AERATION AND MAKE DECISION REGARDING COMPLETE IMPLEMENTATION FOLLOWING RESULTS OF WET WEATHER STUDIES.

Quality of the Lower San Jacinto River (tidal) dominated by the Houston Ship Channel and impacted by dredging activities: PROHIBIT DREDGING IN LOWER SAN JACINTO RIVER DURING CRITICAL DRY WEATHER CONDITIONS.

CLASSIFY BUFFALO BAYOU FOR NON-CONTACT RECREATION USE BETWEEN TURNING BASIN AND ADDICKS/BARKER DAMS. LAUNCH PROGRAM TO DETERMINE DRY/WET WEATHER QUALITY AND STANDARDS TO MEET INTENDED USE, INCLUDING PRESERVATION OF BAYOU AESTHETICS.

FOR ALL OTHER BAYOUS, CONCENTRATE EFFORTS ON PERMIT COMPLIANCE AND KEEPING BACTERIAL COUNTS AT SAFE LEVELS.

CONSIDER EXPANSION OF DESIGNATED 208 PLANNING AREA TO INCLUDE CEDAR BAYOU WATERSHED.

Recommendations of the Areawide Planning Advisory Committee

On the 16th of February, 1978, the Houston Areawide Planning Advisory Committee approved the consideration of the following points:

A clear statement that technical recommendations are subject to change as data are refined and verified.

The understanding that where specific methods of achieving stream standards are recommended, alternate methods of achieving the desired results will be acceptable.

A recommendation to the Texas Department of Water Resources that Armand Bayou be classified as a stream segment.

During the plan update phase, the desirability of classifying other area streams and bayous will continue to be evaluated.

The Texas Department of Water Resources immediately initiate a study leading to review of phosphorous removal requirements for Clear Lake, Clear Creek, and Dickinson Bayou (tidal) in light of 208 technical findings.

Plan implementation should provide for further study of heavy metals, chlorinated hydrocarbons and other toxic materials.

Assignment of high priority to updating population and land use estimates and projections.

Recommendation to expand the designated 208 planning area to include the entirety of the San Jacinto Watershed within the Houston-Galveston Area Council's planning jurisdiction.

THAT, a task force be appointed to outline the specifics of the Water Quality Council with a timetable for completion. In the interim, the public participation program will be continued along with coordination activities of the Texas Department of Water Resources and involvement by the Houston Areawide Planning Advisory Committee.

CHAPTER V-A
ENVIRONMENTAL IMPACTS OF THE PROPOSED IMPLEMENTATION OF THE WASTE TREATMENT MANAGEMENT PLAN

Introduction

Many unsolved problems, situations or specific recommendations still need further definition and data collection. Many variables have been investigated in the alternative plans and many still require data collection, such as the nonpoint runoff phenomenon. But, this is true in any planning process that is progressing in time. Future planning activities will hopefully solve some of the unknowns and advance the level of water quality for urban regions.

The following chapter begins to identify the impacts, both primary and secondary, relative to the proposed plan, but impacts alone are not sufficient. Chapter Six also addresses the issues of mitigating measures or steps which may minimize and adverse impacts or effects. The impacts and mitigating measures are then addressed in Chapter Seven, entitled Assessment Methodology.

Rather than being a definitive, scientific procedure, many value judgements are incorporated into the impacts, mitigating measures and assessment methodology. Many factors in an evaluation such as this cannot be incorporated into a cost/benefit analysis of impact. Thus, relative impacts become important as do specific impacts such as dissolved oxygen. Questions constantly arise relative to issues such as; How much impact is too much on wildlife habitats or aesthetic factors?

Especially in the area of nonpoint source impact, sufficient data does not exist to determine actual impact but sample areas and general trends do exist. Therefore, the sections on input and mitigating measures are meant to be a guideline for future impact assessments and studies. Future projects will hopefully continue to refine the process with better data and information.

CHAPTER V-B
LAND USE

Introduction

In addressing the implementation of the plan one major point must be made relative to land use and demographic characteristics. This point is that the 208 program is a function of land use not instigator of growth. Thus the impacts of the 208 program, per se, are positive asfar as primary impacts are concerned. The major impacts are then secondary and tertiary to the 208 Waste Treatment Management Plan.

Although the proposed plan does recommend the upgrading of sewage treatment plants to appropriate levels, the nonpoint pollution resulting from the land use itself is still in question and will, we believe, create an adverse impact in time. In most of the basins analysed the results of the coincident land development will create the phenomena of increased runoff volume and thus undoubtedly require new pressures for rectification and stream channel modifications. This modification will impact the major wildlife habitats of the Houston area.

The major habitat in the area is the stream bottom vegetation and generally correlates to the 50 year floodplain. The proposed growth and its current and proposed regulation will in our opinion eliminate or severely modify this habitat, but is considered a secondary impact to the 208 program. However, it must be recognized in the 208 efforts and the environmental assessment.

Relationship of Land Use to Impact by Subbasin

Lake Houston Subbasin

Spring Creek. In Spring Creek, the level of water quality is high in comparison to the other basins and exceeds the fishable, swimmable standards based on the assumption that current permitted levels of treatment in fact occur and will continue. Because of significant projected growth in the Spring Creek area and the significant amount of erodible soils that do occur in the watershed, the nonpoint source pollution loads and particularly the suspended solids should be considered an item of concern. Their potential impacts on the elements that also require close observation, are major wildlife habitats, i.e. mixed hardwood stream bottoms, potential archelogical sites/indian sites, and increasing flood plain elevations due to increased runoff.

Cypress Creek. Because the major growth occurs in the heavily wooded portions of the watershed, the major impact of growth will again, as in Spring Creek, be in the forested habitats and the remaining portions of the bottomland hardwoods. This, combined with the dissolved oxygen problem in the same area and nonpoint source loads in the form of benthic oxygen demands, form the major problems and impacts. The development pace in the watershed will again create pressure for the modification of the stream channel and the elimination of the bottomland hardwood habitat. Erodible soils in the near vicinity of the creek and the sediment loading are affiliated factors relative to the urbanization of the watershed and the wet weather conditions. The phenomena of the 98,000 tons of suspended solids for Cypress Creek and the 70,200 tons of suspended solids for Spring Creek must be verified and identified in order that the true impact can be determined. Some limited control strategy should be implemented relative to the suspended solids problem.

Reduced agricultural land uses also need to be monitored. These two watersheds plus the San Jacinto River lead to the Lake Houston area and the nutrient loading concern. The fact that no controls are being placed on the phosphorus loading will create an eventual impact on Lake Houston, if the additional studies data verify the current assumptions.

Clear Lake Subbasin

The Clear Creek Watershed presents a new and unique impact which is subsidence and the potential nutrient loading problem relative to Clear Lake. The fact that the impact on the water quality has already occurred may also be of importance. Again the suspended solids problem needs further study and clarification and the impact of runoff must be defined. Wildlife habitats are a key resource in certain areas of the watershed and need to be identified for future impact.

The Clear Creek tidal area presents a changing aquatic wildlife habitat that because of the basic nature of the stream and the subsidence problem, relative to future growth and hurricane frequency, must be considered in future studies. The unique wildlife habitats of the Texas Gulf Coast such as are demonstrated in the Armand Bayou can be classified as nearly extinct and require close observation.

Houston Ship Channel and Tributaries

This watershed is considered to be an existing urbanized watershed but does show an improving quality over time based on the assumption that all point source discharges are meeting permit requirements. What should be monitered is the continued improvement in quality. The Buffalo Bayou portion takes on a unique value because of the scenic and recreational nature. The existing forested portions of Buffalo Bayou are a modified stream bottomland habitat. The major element that needs to be of concern is the development of the upper reaches causing increased potential for flooding in the lower reaches. Several historical sites exist and must be considered.

The other tributaries of the Houston Ship Channel must be considered for what they are, i.e. wastewater return channels during dry weather. The most important thing is to not allow the quality to degrade and a concious effort could be made to bring back some of the scenic and aesthetic values. Again the major issue from an assessment standpoint in the Houston Ship Channel and San Jacinto River (Tidal) is subsidence and the coastal-bay habitats.

Relationship of Land Use to Specific Issues - All Watersheds

Nonpoint Source

Although nonpoint source pollution data is virtually nonexistant for the 208 planning area, and the recommendation of the proposed plan is to rectify this situation, the state of the art is sufficent to make certain projections of possible input. This topic was researched extensively in the H-GAC report "Control Strategies, Costs and Impacts for Nonpoint Sources". In chapter IX the topics are discussed in detail and are summarized as follows:

Structural Strategies: Retention/Treatment. Retention/treatment strategies will create the need for government expenditures and major construction. An example of this would be retention ponds placed strategically throughout the 208 planning area, or physical/chemical treatment facilities constructed at various collection points.

1) Impacts of Planning.
   Public hearings and associated publicity could result in anticipation of land speculation.

2) Impacts of Construction.
   a. The impact of land use for nonpoint pollution control is contingent on site location, amount of land needed, availability, adjacent land use and the demand for land in a specific area. The impact to adjacent land can be beneficial or adverse. For example, a larger permanent retention pond would increase the desirability of adjoining lands, while a larger treatment facility would have the opposite effect.
   b. A large land requirement, would increase the market value of existing land, developed and undeveloped.

3) Impacts of Operation and Maintenance.
   The type of operation would describe the parameter for impacts to land use. Operation and maintenance impacts would most likely continue the trend in land use affected at the time of construction.

Non-Structural Strategies: Policy/Regulatory. Policy and regulatory strategies are delineated by policies and regulations that call for management practices in the prevention of nonpoint source pollution.

1) Impacts of Planning.
   Possible increase in land buying activities for construction before the regulations are put into effect.

2) Impacts of Implementation and Enforcement.
   Management practices could preclude some land uses.

These brief statements then relate to the "Overall Strategy Rankings". In the ranking of strategies, the product allows one to select what strategies should emphasized. This is covered in the discussion on mitigating measures (Chapter VI).

CHAPTER V-C
ECONOMICS

Introduction

The economic impacts of the recommended Waste Treatment Management (208) Plan have been evaluated by comparing estimated costs of the plan to the projected baseline costs. Effects upon public expenditures and revenue mechanisms have been evaluated. The Plan's influence upon land value and employment has also been addressed. The analysis of impacts is limited by the detail with which baseline conditions may be defined with existing data.

Baseline conditions assume continuation of current trends. According to U.S. Environmental Protection Agency guidelines for Environmental Assessment of Water Quality Management Plans, January, 1977,

> "The 'without case', or baseline projections, also assumes continuation (as appropriate) of existing public policies in the environmental (i.e., non-208 actions, such as federal treatment standards) and other fields that may impact upon the local economy."

This report utilizes baseline costs assuming municipal wastewater treatment plants, existing and future, will comply with treatment standards established by the Texas Department of Water Resources. Industrial discharge is assumed to comply with federal regulations requiring Best Practicable Control Technology (BPCT) by 1977, and Best Available Control Technology (BACT) by 1984. The failure of treatment plants to comply with existing standards is a major contribution to present water quality problems in the 208 Planning Area. The cost of compliance may be substantial, and has been included in the estimation of baseline costs.

Impacts to direct costs for municipal treatment have been analyzed using cost estimates prepared for "alternative technical sub-plans." Where new treatment standards, techniques, or strategies have been recommended within a subbasin , then the cost of that measure is substituted for the estimated baseline cost. No changes were proposed for industrial treatment. Cost estimates had not been developed for proposed non point source pollution control programs. Proposals in the recommended plan have been analyzed for affects upon the current system of distributing wastewater treatment costs. May proposals be funded within the authority of existing entities? Indirect effects of proposed changes in wastewater treatment have been addressed.

Direct Costs

The recommended 208 Plan proposes changes to treatment standards or treatment provision only in a limited number of subbasins. The proposed changes in municipal treatment will increase treatment costs in some cases, and will decrease costs in other cases, resulting in a net decrease in the cost of municipal sewage treatment in the 208 Planning Area. The plan maintains baseline standards for industrial waste treatment. Therefore, the recommended 208 Plan does not increase costs for industrial wastewater treatment, although costs of industrial treatment may rise as industries comply with the existing schedule of treatment regulations.

Municipal Treatment Costs

Costs estimated for municipal treatment under the proposed 208 Plan have been compared to base line estimates of cost in the absence of a 208 Plan. Changes in treatment are proposed in only three subbasins. The estimated total present worth cost of municipal treatment in the 208 Planning Area is $474,300,000 under the proposed Plan. This is a decrease in cost of $7,600,000 from the present worth cost of $481,900,000 for treatment under existing standards. This is a 2% difference in cost. Proposed regionalization in the Cypress Creek Subbasin achieves a savings. If only the cost increases of the selected 208 Plan are realized, the increase in total cost is still only 1%.

Base line cost estimates assume existing plants comply with present permit standards. In many of the subbasins desired water quality can be achieved under current permit standards with 1995 waste loads, even in streams that do not currently meet desired water quality standards. The costs of meeting current standards are a substantial prerequisite to achieving desired water quality under the proposed 208 Plan and are included in the estimation of costs under the Plan.

Estimated costs of municipal treatment under the proposed 208 Plan are listed for each subbasin in the accompanying table. Treatment theme and number of plants are listed for each subbasin. Except where indicated for the Cypress Creek subbasin the Plan recommends continuation of non-regional sewage treatment. Water quality achieved under the plan is listed and the direction of change in water quality is indicated. Both the total cost and the cost per million gallons per day are listed as well as the difference in each under the plan.

TABLE V-C-1

COST IMPACTS OF PROPOSED 208 PLAN

	BASIN	EFFLUENT SET	OTHER TREATMENT	NO. OF TREATMENT PLANTS	WATER QUALITY ACHIEVED	WATER QUALITY CHANGE	COST	COST CHANGE	COST/ MGD	COST/ MGD CHANGE
1.	Spring Creek	2	Semi-Regionalization	32	III	0	$21,700,000	0	$2,550,000	0
2.	Cypress Creek	2N		5	I	0	31,300,000	-12,800,000	2,580,000	-1,060,000
3.	Lake Houston	2N		10	III	0	6,800,000	0	1,630,000	0
4.	Basin Subtotal			47			$59,800,000	-12,800,000	2,410,000	- 520,000
5.	Clear Creek-Nontidal	4NA		10	III	+	23,400,000	+ 2,400,000	2,170,000	+ 230,000
6.	Clear Creek-Tidal	3N		6	III	0	12,400,000	0	2,100,000	0
7.	Clear Lake	3N		4	III	0	7,800,000	0	7,770,000	0
8.	Armand Bayou	3N		4	I, II	0	13,300,000	0	2,000,000	0
9.	Dickinson Bayou-Non-tidal	1		1	I, II	0	600,000	0	3,330,000	0
10.	Dickinson Bayou-Tidal	2P		3	I	0	5,500,000	0	1,100,000	0
11.	Basin Subtotal			28			$63,000,000	+ 2,400,000	2,130,000	+ 80,000
12	Houston Ship Channel	2	Instream Aeration	11	III	+	21,300,000	+ 2,800,000	1,060,000	140,000
13.	Buffalo Bayou	2		17	I, II	0	80,500,000	0	490,000	0
	Other Tributaries									
14.	White Oak Bayou	2		11	I, II	0	33,300,000	0	1,590,000	0
15.	Brays Bayou	2		24	I, II	0	49,800,000	0	820,000	0
16.	Sims Bayou	2		14	I, II	0	80,900,000	0	620,000	0
17.	Vince Bayou	2		3	I, II	0	7,900,000	0	1,000,000	0
18.	Hunting Bayou	2		5	I, II	0	5,200,000	0	900,000	0
19.	Greens and Halls Bayous	2		27	I, II	0	44,700,000	0	1,960,000	0
20.	Carpenter's Bayou	2		3	I, II	0	2,000,000	0	2,860,000	0
21.	Basin Subtotal						325,600,000	+ 2,800,000	750,000	0
22.	Lower Ship Channel	2		11	III	0	18,800,000	0	-	0
23.	San Jacinto-Tidal	2		11	III	0	7,100,000	0	2,970,000	0
24.	Basin Subtotal			22			25,900,000	0	-	0
25.	TOTAL						$474,300,000	- 7,600,000	970,000	- 10,000

WATER QUALITY LEVELS:

Level I. The water quality that will result from continuing future operations at the existing permitted level of treatment.

Level II. The water quality standards adopted in January 1977 by H-GAC through a combined effort of citizens workshops and advisory committees. These criteria are known as the 1977 standards.

Level III. The water quality standards adopted for implementation in 1983 which are capable of meeting the defined goal of "fishable/ swimmable " streams.

Lake Houston Subbasin

The recommended 208 Plan, if adopted for this basin, would achieve a savings of $12,800,000 present worth cost. Water Quality achieved in the basin would remain the same as under the baseline theme. This savings may be achieved if the recommended pursuit of regionalization in the Cypress Creek subbasin successfully implements semi-regional treatment. The Plan also recommends upgrading plants to 4NA treatment if benthal demand studies indicate the effectiveness of this measure. Should this standard be adopted, semi-regionalization would achieve a savings of only $8,100,000 present worth cost. However, water quality would be improved to fishable and swimmable standards.

In the Spring Creek and Lake Houston Subbasins. the selected plan recommends non-regional treatment at present permit levels be maintained. Regionalization in these subbasins should be encouraged when sufficient growth creates a financial incentive. Municipal sewage treatment in this basin will remain the most expensive on a per unit basis of any of the basins in the 208 Planning Area. Although treatment costs in the Cypress Creek Subbasin will drop by approximately $1,000,000 present worth cost per million gallons per day, treatment costs in that subbasin remain relatively high.

Clear Lake Subbasin

The recommended 208 Plan would increase municipal treatment costs in this basin by $2,400,000 present worth cost, or by 4%. The estimated total cost under the plan is $63,000,000 present worth cost compared to $60,600,000 under current permit standards. Water quality improvements would be achieved in three subbasins. The plan recommends changes in treatment in the Clear Creek-Nontidal Subbasin. Non-regional treatment under current permit standards will continue in the Clear Creek-Tidal, Clear Lake, and Armand Bayou subbasins, and Dickinson Bayou-Nontidal and Tidal

In the Clear Creek-Nontidal Subbasin the Plan recommends upgrading treatment standards to effluent set 4NA. However, increasing treatment standards will raise costs to the basin by $2,400,000 present worth cost. Unit costs will increase by $230,000 to $2,170,000 present worth cost per million gallons per day. These changes will improve water quality in the subbasin, approaching or meeting fishable and swimmable standards.

Upper Houston Ship Channel Subbasin

Costs of treatment within this basin will remain approximately the same under the recommended 208 Plan. The Planning Area's greatest expenditures for treatment take place in this basin. The estimated cost of treatment under the Plan is $325,600,000 present worth cost, an increase of less than 1% over the $322,800,000 cost of treatment under the present system. The unit cost of treatment is significantly lower in this basin than in the other basins of the planning area. The cost with the plan is estimated to be $750,000 present worth cost per million gallons per day. The unit cost under the proposed plan is within rounding error of the cost under present permit standards.

The only change in municipal treatment proposed under the plan is instream aeration at the Turning Basin and in the vicinity of Brays Bayou. This will raise the cost of treatment in the Houston Ship Channel by $2,800,000 to $21,300,000 present worth cost. Water quality in the Ship Channel would be improved to fishable and swimmable conditions.

San Jacinto River - Tidal Subbasin

The recommended 208 Plan suggests no changes to treatment in this sub-basin. Under present permit standards the river should reach fishable and swimmable quality. Costs will remain at baseline level under the proposed Waste Treatment Management Plan.

The recommended 208 Plan proposes continued water quality studies in each basin. In most basins monitoring is necessary to establish a wet-weather data base in order to evaluate non-point source pollution controls. Additional areas of analysis include studies of benthal loads in Cypress Creek, of eutrophication in Lake Houston and Clear Lake, and of the feasibility of intrabasin transport from Clear Creek Subbasin. The costs of these studies have not been estimated, but will contribute to research and administrative costs under the 208 Plan. Proposed regulation of residual chlorine would introduce a marginal increase in the costs for municipal treatment facilities.

Industrial Treatment Costs

The proposed 208 Plan introduces no changes to costs of industrial wastewater treatment. Federal standards independent of the 208 Plan require industrial dischargers to implement Best Practicable Control Strategy by 1977 and Best Available Control Strategy by 1984. Costs of complying with these standards are assumed as baseline. The recommended Water Quality Management Plan proposes no changes to these standards and no further restrictions upon industrial wastewater discharge.

Nonpoint Source Control

The major effort toward nonpoint source pollution control proposed in the 208 Plan is the recommendation of wet weather monitoring studies and implementation of Best Management Practices. Wet weather monitoring and modeling will impose research and administration costs. These costs have not been estimated. Best Management Practices, or non-structural controls, are dependent upon regulation and administration rather than treatment facilities. These measures include septic tank ordinances, regulation of dredging, street sweeping, anti-litter ordinances, erosion control, green-belt zones, and restrictions on use of fertilizers and chemicals. Best Management Practices are not capital intensive but will require expenditures for regulation and administration.

The proposed 208 Plan does recommend trial implementation of nonpoint source pollution controls in the Clear Creek Nontidal Subbasin. Trials would test "good housekeeping techniques" (street cleaning and refuse collection), vegetative controls, and small scale retention. Simultaneously, reserves would be set aside in drainage ways of future developments, providing space for implementation of nonpoint source control. Should wet weather monitoring demonstrate the effectiveness of control measures, controls would be implemented in the space provided by reserves. This program would entail costs for research and administration as well as the cost of retaining reserves along drainage ways. Reserves may be provided either through purchase by public authority, or by regulation of land development. The cost of retaining land reserves will vary according to the quantity of land reserved and land values at the affected location. If wet weather monitoring confirms water quality problems in other drainage basins within the Clear Lake Subbasin, similar controls are recommended.

In the Houston Ship Channel Subbasin if wet weather monitoring confirms water quality problems in other watersheds, the 208 Plan recommends institution of urban runoff controls or re-definition of the stream segment's water quality standard. Because this watershed is highly urbanized, retention and treatment of stormwater is the only feasible means of reducing runoff waste loads. The volume of runoff flowing into the Ship Channel from tributaries and inflow on the day of the storm is over twenty billion gallons. The cost of treating this volume chemically would exceed $1 billion while the less effective technique of screening with microstrainers would cost $350 million. These extremely costly measures would be implemented only if the problem is verified by the monitoring program and if the presently defined water uses for the channel are chosen to be maintained.

Distribution of Direct Costs

This section examines the entities providing water pollution control measures specified in the 208 Plan to determine where new costs or increased costs proposed in the Plan will require new funding mechanisms. In some cases existing entities can assume increased costs, obtaining increased revenues from higher taxes on a greater volume of user charges. Where proposals of the plan require functions to be coordinated on a scale wider than provided by currently functioning agencies, either existing agencies with broader jurisdictions must accept new responsibilities or new entities must be created.

Municipal

Both facility costs and administrative costs incurred under the 208 Plan must be distributed through public entities to the public. Increased facility costs are proposed in only three subbasins, throughout the rest of the planning area no change in cost distribution methods are required. Enactment of the plan will introduce administrative costs requiring distribution through the planning area.

Regionalization of treatment in the Cypress Creek Subbasin will require coordination of the separate Water Districts currently providing non-regional treatment within the subbasin. The total capital costs of a regional facility may overextend the bond limits of the relatively small water districts requiring financing of the facility by a larger umbrella entity. Water districts would then contract with the regional entity for sewage treatment service. The coordination and financing of regional treatment may be accomplished through existing authorities or by creation of a new entity.

Upgraded effluent standards for municipal treatment plants will increase treatment costs within the Clear Creek Nontidal Subbasin. Treatment will continue to be furnished by small non-regional plants. The increased costs may be funded through existing mechanisms for financing municipal wastewater treatment in the subbasin. The proposed water quality management system under the 208 Plan, when it becomes effective, may facilitate regionalization of treatment in this watershed affording cost savings.

Research and associated administrative costs will require distribution by agencies with jurisdiction over each or several subbasins.

Industrial

The recommended 208 Plan proposes no changes to industrial wastewater treatment. Costs for treatment of industrial effluent will therefore remain at baseline levels and will be funded through exisiting mechanisms.

Nonpoint Source Control

Wet weather monitoring and implementation of Best Management Practices are the core of the recommended 208 Plan's proposals for control of non-point source pollution. Because the measures should be applied throughout the planning area , an agency with jurisdiction over the entire area is most suited to the administrative and regulatory tasks that constitute non-structural controls. However, street cleaning and refuse collection, "good housekeeping procedures," are functions provided by municipalities and private contractors. Preservation of vegetation in drainage ways or requirement of small-scale retention must be accomplished through the subdivision regulation authority vested in city government. Many of the functions of "Best Management Practice" must be accomplished by cities and water districts within sub-basins, although coordinated by an agency with jurisdiction containing subbasins or basins in their entirety.

Trial implementation of nonpoint source pollution controls in the Clear Creek-Nontidal Subbasin and possible future implementation of such controls in other subbasins of the Clear Lake Basin will require an agency with the power to purchase land reserves or easements or the authority to include such reserves among requirements for subdivision approval. If the agency purchases rights-of-way or easements, it must have the power to raise funds either through sale of general obligation bonds secured by ad valorem taxes or by appropriation from other public entities. If reserves are stipulated in subdivision regulations, the cost of the land will be reflected in higher lot prices.

Treatment of stormwater entering the Houston Ship Channel and tributaries would require an enormous capital investment as well as continued operation and maintenance costs. The City of Houston is the major public source of discharge into the stream and the probable entity responsible for treatment of urban runoff should such measures be imposed. Capital costs met by the city would be funded by general obligation bonds secured by ad valorem taxes.

Indirect Costs

The recommended 208 Plan proposes continued provision of wastewater treatment facilities in response to growth within the region. This policy should promote water quality with minimum disruption of the area's development. Possible effects upon land value will be minimized. Because the proposed plan does not alter industrial wastewater effluent standards, it will have minimal effects upon regional employment.

Land Value

Wastewater treatment issues affecting land value are the provision or refusal of service, relative increases in taxation and the nuisance value of treatment facilities or polluted waters. The proposed 208 Plan alters the existing system of providing municipal wastewater treatment in only three subbasins.

Because the preferred 208 Plan proposes accomodation of future growth, it should not depress land values by denying or inhibiting provision of sewer services. In all but three subbasins, the existing system of non-regional wastewater treatment at current permit levels is maintained. The effects upon land value due to service and taxation for these three subbasins are discussed below. Installation of new facilities in all of the Planning Area will have localized effects, depressing land value in the immediate vicinity of treatment plants.

Cypress Creek

In the Cypress Creek Subbasin the Plan suggests pursuit of regionalization and upgrading treatment plants to 4NA treatment standards should benthal demand studies demonstrate the effectiveness of that measure. Increasing effluent standards would raise treatment costs, however, savings from successful regionalization would more than compensate for this increase. Even with these savings, the cost of treatment per million gallons per day remains high in this subbasin relative to others in the planning area. Differences in tax rates in this subbasin relative to others could not be attributed to effects of the 208 Plan.

Regionalization is recommended for implementation where financially feasible. The proposal does not proscribe non-regional plants, thus no areas that could be provided service under the present system will be denied service. The plan should not cause decreases in land value by denying or inhibiting provision of sewer services to otherwise developable sites. Because of lower treatment costs, regionalization would decrease the cost of sewer service to areas within the radius where treatment cost savings were not off-set by conveyance costs. The lowered cost of sewer service would increase the ease with which the land within the service area of the plant could be developed, contributing to the land's value.

Regionalization if implemented should increase the feasibility of some sites heretofore too distant from potential discharge locations. Wastewater treatment costs per unit flow are less for large, regional facilities than for smaller, non-regional plants. Sewer service from the larger regional plant is feasible within the radius where savings in treatment costs are greater than the cost of conveyance to the regional plant. Sites that fall within the radius of service from a regional plant, but whose distance from potential outfall prohibited construction of a non-regional plant, will become feasible sites for development and should rise in land value.

Clear Creek-Non-tidal

Upgraded treatment requirements in this subbasin will increase treatment costs requiring higher taxes. However, even with the proposed increases in cost, the cost per million gallons per day treated remains comparable to other subbasins in the Clear Creek/ Clear Lake Basin. The cost increase should not affect taxes relative to comparable areas sufficiently to signficantly affect land values in the subbasin.

Houston Ship Channel

The preferred 208 Plan recommends installation of instream aeration only after further studies have verified that wet weather water quality in the stream is within a range that allows achievement of dry weather quality. Although the cost of this measure is an increase of approximately 10% over the cost of treatment for the subbasin , it is an insignificant increase in the total cost of treatment for all the tributaries contributing to the waste load in this stream segment. If this measure is adopted, and if its cost should require an increase in taxes, the increase would have an insignificant affect upon land value in the subbasin . Transportation and proximity to adjacent industries will remain dominant determinants of land value in the sub-basin.

Instream aeration could achieve dissolved oxygen levels capable of supporting aquatic life. Significant increases in water quality can foster increases in land value. However, improved water quality primarily affects the value of residential property. The homogenous industrial development adjacent to the Ship Channel and the volume of shipping traffic on the stream preclude significant benefits to residential land values.

Employment

The proposed 208 Plan will not effect basic industry in the planning area. Effects it may have on the area's employment may not be projected. The recommended plan does not propose additional effluent standards nor will it restrict industrial discharge. The plan does not proscribe or specify industrial locations. Because total employment is projected from employment in basic industry, the plan will not effect projected employment.

Summary

The proposed Waste Treatment Management Plan will reduce municipal wastewater treatment costs for the 208 Planning Area and will introduce new research and administration costs. Because the plan proposes no changes to industrial discharge standards, it should have no effect upon basic industry, and consequently no discernible effect upon projected employment.

The plan proposes changes affecting municipal treatment costs in only three subbasins . Proposed regionalization in the Lake Houston Subbasin would achieve a cost savings outweighing increased costs for upgraded treatment standards proposed for the Clear Creek-Nontidal Subbasin and instream aeration suggested for the Houston Ship Channel.

The treatment costs estimated for each subbasin are costs for systems capable of meeting either existing or, where proposed, upgraded treatment standards. The baseline costs do not estimate the cost of operating existing plants at permit standards. Because failure to meet these standards has been one of the causes of the Planning Area's water quality problems, costs to achieve permitted levels are a substantial portion of cost estimates for the area's municipal treatment systems.

Wet weather water quality monitoring and modelling, and institution of "Best Management Practices" are the plan's major proposals for non-point source pollution control. These programs will entail research and administrative costs, costs which have not been estimated. In the Clear Lake Basin, the plan recommends institution of control measures that may entail costs for purchase of land or easements. These costs will depend upon decisions regarding purchase versus regulation and upon the extent of implementation through the watershed. These decisions are to be made after trial implementation of control measures.

Implementation of the 208 Plan will require funding of areawide coordination of wastewater treatment, water quality monitoring, and "Best Management Practices" for nonpoint source pollution control. Regionalization in the Cypress Creek Basin will require an agency through which to finance the required larger treatment plants. Implementation of nonpoint source controls in the Clear Creek-Nontidal Subbasin will require an entity with authority throughout the subbasin. These proposed tasks may be accomplished through either re-defining the role of existing agencies or by creation of new agencies. Proposed upgraded treatment standards in the Clear Creek-Nontidal Subbasins and instream aeration in the Houston Ship Channel may be funded through existing mechanisms.

Indirect economic effects of the proposed 208 Plan will be minimal. The plan is formulated to accomodate growth rather than control development and proposes changes to municipal treatment schemes in only three subbasins. Over the majority of the Planning Area proposed measures will not affect land value. Regionalization in the Cypress Creek Subbasin may make feasible sewer service to previously unserved areas, thereby increasing land value in those areas. Proposed changes to municipal treatment in the Clear Creek Nontidal Subbasin and the Houston Ship Channel should not affect treatment costs in those basins relative to comparable areas sufficiently to affect relative land values.

Industrial discharge standards will not be altered by the proposed 208 Plan. Although industrial treatment costs may increase due to federally imposed industrial effluent standards, no new restrictions will be imposed under the Plan. Because it will not affect the output of basic industries, the plan will have a minimal impact upon the planning area's projected employment.

The recommended 208 Plan if implemented will achieve a savings in municipal treatment costs. It will require new research and administration costs. The plan should have a minimal effect upon land value in the planning area and an indiscernible effect upon projected employment.

CHAPTER V-D
WATER

Introduction

The impacts of the preferred technical subplans on both the hydrology and water quality of selected stream segments in the HGAC planning area is addressed in this chapter. For technical information see Chapter 3 or the Alternative Technical Subplans report.

Impacts of the Preferred Technical Subplans on the Hydrology of Selected Stream Segments in the 208 Planning Area

The hydrology of the selected stream segments in the 208 planning area as a result of implementation of the preferred technical subplans will remain unchanged from the baseline hydrologic conditions evaluated in Chapter II-D of this report.

In several cases the Alternative Technical Subplans report suggests non-structural controls of storm water runoff. These controls would not alter the hydrology of those stream segments for which they are proposed.

Impacts of the Preferred Technical Subplans on the Water Quality of Selected Stream Segments in the 208 Planning Area

Lake Houston Subbasin

Spring Creek. Segment: 1008
Water Quality Level Achieved: III*
The result of implementing the preferred technical subplan will be to meet or exceed the fishable/swimmable goal of not less than 5 mg/l* of dissolved oxygen and not more than 200 MPN/100 ml* of dissolved oxygen and not more than 200 MPN/100 ml* of fecal coliform.

* mg/l = milligram per liter
* MPN/100 ml = most probable number of coliform organisms per 100 milliliters
* Level I is defined as the water quality in 1995 with present effluent permits. Level III is fishable/swimmable water quality. Level II is between I and III. If present permits achieve fishable/swimmable water quality in 1995, Level I is by definition Level III.

In a five mile section of the creek near River Mile 30, the water quality modeling results indicate a dissolved oxygen concentration of 4.8 mg/l. The difference between 4.8 mg/l and the goal of 5 mg/l dissolved oxygen may be attributed to the accuracy of the model and disregarded as a violation of the fishable/swimmable goal for the segment.

The wet weather analysis of the segment, for which no calibrated model exists, indicates a possible minor fecal coliform violation of the fishable/swimmable goal. However, the plan does call for further study and calibration of the wet weather model with appropriate action if necessary.

Cypress Creek. Segment: 1009
Water Quality Level Achieved: I or III

The preferred plan for Segment 1009 is a two-phased approach to the fishable/swimmable water quality goal for this segment. Water quality simulations for this segment using various treatment schemes have shown that the fishable/swimmable goal for Cypress Creek is only attainable by assuming a 65% reduction of the present benthic oxygen demand, while upgrading most treatment plants in the segment to a 4NA level. The plan suggests allowing existing plants to continue at presently permitted effluent levels and permitting new plants to be built at presently permitted levels while showing plans to upgrade to level 4NA. If further studies of the benthic oxygen demand, as called for by the selected plan, do indicate that the benthic demand is reduceable by 65%, then most treatment plants in the segment will be required to upgrade to the 4NA treatment level.

This plan has two possible adverse effects to the ultimate fishable/swimmable goal for Cypress Creek. First, the plan makes no provision for the possibility that further study will indicate that a 65% reduction in benthic oxygen demand is not possible. Secondly, it is obvious that at least a 4NA treatment level will be required to meet the fishable/swimmable goal for this segment whatever the benthic study shows. Therefore, allowing future plants to be permitted at present effluent levels will further degrade the water quality in this segment.

It is indicated in the steady-state modeling draft report by the Texas Department of Water Resources for Cypress Creek that the amount of chlorine residual in Cypress Creek was high during a survey of the creek. As a result, BOD decay rates, which were calibrated for the segment with the high chlorine residual, may not be applicable to simulation of 1995 water quality since maximum chlorine levels may be lower, at that time, as proposed in the preferred plan. The higher BOD decay rates, which would exist with lower chlorine loadings, may result in depressed dissolved oxygen levels which were not predicted by the simulations.

Lake Houston. Segment: 1002
Water Quality Level Achieved: III

The preferred technical subplan for Lake Houston will meet or exceed the fishable/swimmable water quality goals for the segment. The only concern at present is eutrophication of the lake due to the nutrient loadings. The preferred plan adequately addresses this issue by calling for further analysis of the eutrophication potential of the lake, along with detailed planning studies.

Clear Creek/Clear Lake

Clear Creek Nontidal. Segment: 1102
Water Quality Level Achieved: III

The effect of the preferred plan on the nontidal Clear Creek segment will be to improve the critical dissolved oxygen concentration by 2.5 mg/l over the concentration predicted with Level I treatment as described in the Alternative Technical Subplans report.

The preferred plan calls for a lowering of the dissolved oxygen goal of 5 mg/l to 4.5 mg/l, which is the critical value predicted by the simulations using Treatment Theme 3. This 0.5 mg/l reduction in the dissolved oxygen goal for the segment should have no major adverse effect on the water quality in the segment.

The simulations of the Clear Creek nontidal segment make use of the same assumptions regarding benthic oxygen demand reductions as do the predictions for Cypress Creek. The same precautions as suggested in the Cypress Creek nontidal section of this report should be applied here. Essentially, the preferred technical subplan for this segment makes no provisions for the possibility that a 65% reduction in the benthic oxygen demand will not be achieved.

The preferred plan recognizes the need to control nonpoint source pollutant loads to the segment if the 4.5/200 fishable/swimmable goal for the segment is to be met. The recommended control strategies for Clear Creek according to the Alternative Technical Subplans report are vegetative control, small scale retention, and "good housekeeping" methods. The plan also recognizes the need to study the efficiency of the pollution removal these nonpoint source controls will have.

This method of approach should provide acceptable water quality in the Cypress Creek nontidal segment if the prescribed studies are carried out.

Clear Creek Tidal. Segment: 1101
Water Quality Level Achieved: III

The results of implementing the preferred technical subplan will be to attain a fishable/swimmable water quality level in the segment at the presently permitted effluent level. No wet weather analysis was done for this segment, but the preferred technical subplan does make provisions for further studies of the segment under runoff conditions.

Clear Lake. Segment: 2425
Water Quality Level Achieved: III
The preferred plan results in this segment will be fishable/swimmable water quality. However, implementation of the preferred technical subplan for Clear Lake may produce serious eutrohpication problems in the future due to the recommendation for eliminating phosphorus treatment requirements by permitted dischargers. The Alternative Technical Subplans report indicates that the phosphorus loading to Clear Lake with implementation of the preferred plan will be an order of magnitude greater than the level considered conducive to eutrophication effects. It should be mentioned that eutrophication of this segment may lead to violations of the fishable/swimmable goal which were not predicted by the model simulations.

Armand Bayou. Segment: Unclassified
Water Quality Level Achieved: II
The effect of the preferred plan on the water quality of Armand Bayou will be to maintain present water quality levels which do not meet the fishable/swimmable water quality goal for this unclassified segment. The plan is based on an unverified, uncalibrated steady-state model of the segment. As a result the plan calls for further detailed study of the area in order to develop a more accurate water quality simulation model. The results of the further study, according to the subplans report, will be utilized to recommend "realistic goals" for the bayou.

Dickinson Bayou. Segment: 1104 (nontidal)
Water Quality Level Achieved: III
Segment: 1103 (tidal)
Water Quality Level Achieved: II
The preferred plan for both the tidal and nontidal segments of Dickinson Bayou is to continue present permitted discharges until further modeling results are available to assist in choosing what controls are necessary to achieve fishable/swimmable goals. The effect of the plan on water quality will be to maintain present day quality in the bayou which does not satisfy the fishable/swimmable goal for dissolved oxygen, but does meet the fecal coliform standards of 200 MPN/100 ml.

Upper Houston Ship Channel and Tributaries to Confluence with the San Jacinto River

Houston Ship Channel. Segments: 1005, 1006, 1007, 2426, 2427, 2428, 2429, 2430
Water Quality Level Achieved: III
As part of the preferred technical subplan for these segments, it is recommended that the dissolved oxygen goal for the Houston Ship Channel be lowered from 5.0 mg/l to 4.0 mg/l. This lowered dissolved oxygen level would by definition be Level III water quality, and with implementation of the plan, it would be achieved as indicated by the results of the water quality modeling effort.

The preferred plan recommends an intensive monitoring study and the development, calibration, and verification of a dynamic wet weather model of the Houston Ship Channel and associated bays. The result of these activities will help to determine whether a fishable/swimmable level of water quality should be the goal for the Houston Ship Channel, or whether it should be reclassified as an industrial canal. This decision will be based on the water quality response in the Houston Ship Channel to varying wet weather control strategies.

The immediate effect of the preferred plan on the Houston Ship Channel will be to continue permitted discharges at present levels, and thus maintain the water quality at current levels until the additional studies are completed. The current water quality level in the Houston Ship Channel does not meet the fishable/swimmable goal for the segments in the Houston Ship Channel area.

Buffalo Bayou. Segment: Unclassified
Water Quality Level Achieved: II
The preferred plan recommends an analysis of Buffalo Bayou to determine a waste load set consistent with noncontact recreation, which is the water quality goal proposed for the bayou.

The plan will not cause the water quality in Buffalo Bayou to meet a fishable/swimmable level; however, it will, according to the Alternative Technical Subplans report, preserve the natural beauty of the bayou and allow for noncontact recreation.

San Jacinto River. Segment: 1001
Water Quality Level Achieved: III
The preferred plan, if implemented, provides for the continued operation of existing and future municipal point source dischargers at their present permitted levels. The result of implementing the preferred plan will be to meet or exceed the fishable/swimmable water quality goal which is proposed for the segment with the exception of a small area of the San Jacinto River near its confluence with the Houston Ship Channel.

Remaining Unclassified Bayous. The preferred technical subplan for the remaining unclassified bayous (Brays, Carpenters, Greens/Halls, Hunting, Sims, Vince, and White Oak), according to the Alternative Technical Subplans report, is to maintain the permitted levels of effluents presently existing in those basins. The result of this plan is by definition to maintain the present levels of water quality in these bayous, which are below fishable/swimmable quality.

All of the bayous, except Hunting Bayou, according to a non-specific simulation model, will exhibit dissolved oxygen levels between 2 and 4 mg/l. Hunting Bayou will have a level somewhat higher than 4 mg/l dissolved oxygen. All the bayous are projected to have fecal coliform levels below 200 MPN/100 ml.

CHAPTER V-E
AIR

Air Quality

Conditions With The Selected Plan

Introduction. Wastewater treatment plants solve a water pollution problem. However, wastewater treatment processes frequently cause air pollution by air-stripping volatile substances, by injecting particulates into the air through the evaporation of wastewater droplets, and by releasing odorous gases from sludge digestion, screenings, and stable wastewater. The air-stripping of volatile substances and the release of particulates from evaporation occur during the aeration process, which is undertaken to accomplish the biological breakdown of the wastewater. Other pollutant releases occur during the inceneration or grinding and bagging of sludge. These processes can cause particulate emissions.

Projected Ambient Air Quality. Most of the emissions of the primary pollutants in the Houston-Galveston area occur in eastern and southern Harris County, along the Ship Channel. Among the pollutants emitted in large amounts in that area are hydrocarbons, particulates, sulfur dioxide, and carbon monoxide. The primary source of nitrogen dioxide is vehicular traffic; and as a result, the highest concentrations of nitrogen dioxide in the Houston-Galveston area occur in downtown Houston. Both the Ship Channel and the downtown area are located in the Houston Ship Channel Subbasin. The other two subbasins have relatively low quantities of emissions from stationary sources. The majority of emissions in the other two subbasins are from vehicular traffic and are difficult to quantify.

A qualitative estimate of the projected emissions in each basin can be used to estimate the effects and impacts on the future ambient air quality. The incremental increase in emissions that will accompany area growth is the most important factor in evaluating projected ambient air quality.

The implementation of the plan itself will not result in direct impacts on the ambient air quality of the subbasin(s). The major impacts are produced by growth occurring in the affected subbasin. Additional construction to serve projected populations will results in increased particulate emissions. The increased vehicular traffic[1] that accompanies such growth will cause an increase in the emissions of particulates, hydrocarbons, carbon monoxide, and nitrogen dioxide within the subbasin. The major impacts of these increased emissions in the subbasin will be poorer ambient air quality and decreased visibility.

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[1] The increased traffic can be categorized as line sources of emissions (roads) and indirect area sources of emissions (shopping centers and recreational facilities).

Comparison of Future Environments With and Without the 208 Plan

The Houston-Galveston area will expand rapidly during the next decade with or without the implementation of the 208 Plan. The ambient air quality of the area will most likely remain fairly poor with or without the 208 Plan The ambient air quality of the Houston-Galveston area is very poor in many sections, particularly in the eastern half of the Houston Ship Channel Subbasin. The poor air quality has become serious enough to prompt the Environmental Protection Agency to consider the enforcement of restrictions on travel in the Houston-Galveston area in the future. Obviously, such a step would be detrimental to the continued expansions and development of the Houston-Galveston area as a commercial center. The growth of the region would likely slow somewhat if such regulations were enforced.

Summary and Conclusions

The Lake Houston Subbasin has fair ambient air quality and a relatively low volume of pollutant emissions. Conversely, the Houston Ship Channel Subbasin has poor air quality and a large volume of emissions. The Clear Lake Subbasin has fair air quality and a moderate volume of emissions. However, the Clear Lake Subbasin is located between two districts (i.e., the Ship Channel and Texas City) which have poor air quality and large quantities of emissions. In addition, the Clear Lake Subbasin is upwind of much of Houston during most of the year. Therefore, growth in the Clear Lake Subbasin frequently could impact many of the populated areas to the north and northwest of that subbasin.

The following summarization can be made regarding air quality:

Lake Houston Subbasin (Spring Creek). Projected population growth and associated activities will increase emissions and decrease the ambient air quality in the basin by a fairly substantial increment. However, ambient air quality standards would probably not be exceeded on an annual average basis except for particulates, which are a problem throughout the Houston-Galveston area. Moreover, the ambient air quality in other basins would not be impacted appreciably by growth.

Lake Houston Subbasin (Cypress Creek and Lake Houston). The same general effects as those listed for the Spring Creek Basin apply to Cypress Creek and Lake Houston. Ambient air quality standards could be impacted in portions of the subbasin more significantly than in the Spring Creek Basin.

Houston Ship Channel Subbasin. This subbasin suffers from poor ambient air quality and high volume of pollutant emissions. Small incremental increases in emissions and ambient air quality levels are anticipated. However, the impact on the subbasin's compliance with ambient qir quality standards coud be significant; the pollutant levels in the subbasin could cause AQCR(Air Quality Control Region) No 7 to be a non-attainment area for nitrogen dioxide. Moreover, the additional hydrocarbon emissions would probably raise oxidant levels in the Lake Houston Subbasin.

Clear Lake Subbasin. The Clear Lake Subbasin presently has acceptable ambient air quality and a moderate level of emissions. However, districts with poor air quality and high levels of pollutant emissions are located to the north and south of this subbasin. Therefore, any incremental increase in pollutant concentrations or emissions in this subbasin could combine with the already high levels in the surrounding areas to cause a significant deterioration in air quality (i.e., possible non-attainment of particulate and nitrogen dioxide standards) in and around the subbasin. Also, the subbasin is upwind from Houston much of the time; pollutant levels (especially photochemical oxidant levels) could increase in Houston because of significant growth in this subbasin.

and a large volume of emissions. The Clear Lake Subbasin has fair air quality and a moderate volume of emissions. However, the Clear Lake Subbasin is sandwiched between two districts (i.e., the Ship Channel and Texas City) which have poor air quality and large quantities of emissions. In addition, the Clear Lake Subbasin is upwind of much of Houston during most of the year. Therefore, growth in the Clear Lake Subbasin frequently could impact many of the populated areas to the north and northwest of that subbasin.

Considering the effects and impacts that the 208 Plan would have in each of the subbasins, the following summarization can be presented.

Lake Houston Subbasin (Spring Creek). The 208 Plan would increase emissions and decrease the ambient air quality in the basin by a fairly substantial increment. However, ambient air quality standards would probably not be exceeded on an annual average basis except for particulates, which are a problem throughout the Houston-Galveston area. Moreover, the ambient air quality in other basins would not be impacted appreciably by growth.

Lake Houston Subbasin (Cypress Creek and Lake Houston). The 208 Plan would have the same general effects as those listed for the Spring Creek Basin. Ambient air quality standards could be impacted in portions of the subbasin more significantly than in the Spring Creek Basin.

Houston Ship Channel Subbasin. This subbasin suffers from poor ambient air quality and a high volume of pollutant emissions. Implementation of the 208 Plan would result in small incremental increases in emissions and ambient air quality levels. However, the impact on the subbasin's compliance with ambient air quality standards could be significant; the pollutant levels in the subbasin could cause AQCR (Air Quality Control Region) No. 7 to be a non-attainment area for nitrogen dioxide. Moreover, the additional hydrocarbon emissions would probably raise oxidant levels in the Lake Houston Subbasin.

Clear Lake Subbasin. The Clear Lake Subbasin presently has acceptable ambient air quality and a moderate level of emissions. However, districts with poor air quality and high levels of pollutant emissions are located to the north and south of this subbasin. Therefore, any incremental increase in pollutant concentrations or emissions in this subbasin could combine with the already high levels in the surrounding areas to cause a significant deterioration in air quality (i.e., possible non-attainment of particulate and nitrogen dioxide standards) in and around the subbasin. Also, the subbasin is upwind from Houston much of the time; pollutant levels (especially photochemical oxidant levels) could increase in Houston because of significant growth in this subbasin.

CHAPTER V-F
PUBLIC HEALTH

The public health impacts of implementation of the preferred technical subplans, according to the water quality modeling results of the Texas Water Quality Board, will be to adequately satisfy the fecal coliform standards in the classified stream segments in the planning area.

It should be pointed out that the preferred plan addresses only dissolved oxygen and fecal coliform levels in the stream segments which it encompasses. Therefore, the effects of other potentially harmful substances, such as heavy metals and pesticides, as well as carcinogens on public health in the 208 study area cannot be investigated here, as no study was made of these other potential public health hazards. Chapter II-F of this report presents the EPA Water Quality Criterion for such substances.

CHAPTER V-G
BIOLOGY

The future projections for 1995 ecological conditions are similar both with and without plan implementation. Water quality of streams in the HGAC 208 area will improve to reflect provisions of Federal Water Pollution Control Act Amendments and subsequent regulations. The completion of Environmental Impact Statements in accordance with National Environmental Policy Act will aid in preventing the unnecessary destruction of natural resources by federally supported or permitted activities.

Future conditions of terrestrial areas should not be affected by the selected areawide Water Quality Management Plan. Terrestrial resources are affected by land development and the selected plan, as recommended, does not affect land development trends.

Analysis of the selected 208 Plan as it related to biotic resources indicates that few adverse impacts will result from its implementation. Although variances from the fishable/swimmable criteria have been suggested for individual stream segments, these variances are not expected to significantly degrade current water quality conditions. However, reclassification of the Houston Ship Channel below the turning basin as an industrial canal would prevent the ecological recovery of this portion of the stream. Reclassification would also make future industrial development attractive in this basin area because of low effluent treatment costs. The effect of low treatment levels and increased loads along the Houston Ship Channel on the biological resources of San Jacinto Bay and Galveston Bay could be very significant.

CHAPTER-V-H
IMPACT ON AESTHETICS

Introduction

The direct impact of the 208 plan on the aesthetics of the region is minimal, with the secondary effect being the affiliated growth and change. These secondary impacts are then the key factors and are subject to future decisions relative to land use densities or planning activities. The key changes that are anticipated to secondarily occur in the 208 planning area are:

Lake Houston Subbasin/Cypress Creek/Spring Creek

As this area becomes developed, it will have a tendency to loose the upland forest characteristics. Scattered swamps will be drained, and with time, will become an urban-upland forest. Few developments will save understory and/or seedling vegetation. In time the forest will age and disappear if understory and seedlings are not allowed to remain. The mixture of pines and hardwoods will change. Human activity will save the hardwoods and attempt to remove the pines, and the visual characteristics will change.

Houston Ship Channel Subbasin

The urban/industrial complex will continue to be the characteristic of the lower basin. The man-made features will continue and no detremental change is anticipated in the aesthetic characteristics.

In the lower Buffalo Bayou area, the aesthetics are not anticipated to change unless the upper Bayou creates such pressures on the lower bayou. The result of such pressures would cause the eventual removal of the modified natural areas along the bayou.

In the upper Buffalo Bayou area the prairie characteristics will disappear where major residential and commercial development is occurring. The vastness and openness will be replaced with urban prairie and its non-natural vegetation will eventually prevail. The sporadic bottomland forests may be saved due to flood plain controls, however these forests may also be suppressed by drainage relief and development.

Clear Lake Subbasin

This basin exhibits the same aesthetic conditions as illustrated in the upper Buffalo Bayou watershed. Coastal prairie will be diminished, although not as intensely as in the other basins. Pressures for drainage may reduce the bottomland hardwoods and threaten the natural areas, thus reducing the one main physical feature of the overall basin.

CHAPTER VI-A
MITIGATING MEASURES

Introduction

Although hard data is not available, especially in the field of nonpoint source runoff, there does exist means for reduced pollution loading on Houston's streams and bayous. The actual effect of some of these measures is still to be determined or in other cases may be politically unfeasible at the present time. This basically may or may not affect the actual impact. The mitigating measures deals with how to potentially reduce adverse impacts when they are found to be of significant magnitude.

Many of these measures where incorporated into the previous planning studies conducted for the Houston Galveston Area Council 208 Waste Water Management Plan and are contained in the report entitled Control Strategies, Costs and Impacts for Nonpoint Sources. This report is a very comprehensive analysis of possible mitigating measures for the control of nonpoint sources of water pollution. The "Alternative Technical Subplans" report discusses the implications of the point source solutions.

The lack of any real wet weather data is a common problem in most cities. Data collection is just beginning and should be continued and intensified due to the rapid growth situation in the Greater Houston Region.

CHAPTER VI-B
MITIGATING MEASURES
LAND USE

Mitigating measures - Nonpoint

The major emphasis relative to land use and mitigating measures relates to what can be done to minimize any adverse effects. In the "Control Strategies, Cost and Impacts for Nonpoint Sources" a major effort was conducted on the various mitigating strategies for nonpoint source pollution. These strategies were ranked in order of effectiveness, feasibility and applicability. The rankings and brief comments from the report are as follows:

Vegetative Control Techniques

This alternative is the most versatile of all the techniques in that it can be used as either an abatement, control, or treatment measure with equally high effectiveness. As an abatement measure, the maintenance of a good vegetative cover will provide maximum erosion control and prevention, thus reducing the possibility of sediment being dislodged and transported. In preventing sediment transport, the associated oxygen-demanding materials and heavy metals, nutrients, herbicides, and pesticides are also prevented from entering a waterway. A good vegetative cover can be used to slow the velocity of runoff and thus aid in its detention. It can also act as a filter or screen to remove particles from suspension. There are also treatment properties associated with vegetation as related to spray irrigation and overland runoff (more commonly used as a method of tertiary wastewater treatment). Vegetation is also a necessary component of swales, retention/detention ponds, sediment control basins, and infiltration basins to keep them operational. Other secondary benefits include the aesthetics of vegetation especially in connection with the blue-green concept of development, its relative ease of implementation, and the relatively low cost of implementation and maintenance.

Erosion Control of Construction Activities

Due to the high amount of construction work planned and in progress, these alternatives have been judged to be very important in the 208 area. The actual area of construction may be very small in relation to the entire 208 area, but the localized damage due to construction activities is quite severe. Erosion is not only the source of sediment but also can damage or destroy public structures such as highways and bridges, leading to further problems or hazards. It is also aesthetically unpleasing and gives an appearance of irreparable damage and devastation to the landscape or stream. Thus, the importance of controlling erosion is realized in a number of ways. Also, most of the measures will be relatively easy to implement and have relatively low construction and maintenance costs.

Sediment Control of Construction Activities

The sediment resulting from erosion carries oxygen-demanding materials, suspended solids, toxic substances, and such substances as nutrients, pesticides, and herbicides. Sediment can clog drainage ways and structures increasing the potential for flood damage. Thus, the importance of controlling erosion and sediment is realized in a number of ways. Also, most of the measures will be relatively easy to implement and have relatively low construction and maintenance costs.

Small Scale Retention

This category ranks high because of its low cost, feasibility, and applicability. These strategies are not as effective as many others, but they can be incorporated easily into building design, parking lot designs, and the planning of new shopping malls and developments. In many cases no one would be aware of them so there is no detrimental aesthetic value. Also, the fact that they can easily fit into existing designs and require minimal maintenance make them very attractive economically. The low land requirements and, in the case of rooftop and parking lot ponding, no land requirement is very important.

Agricultural Runoff

The high ranking of this category was mainly due to the large area involved and the relatively low capital and operating costs involved. The area of agricultural land where pollution controls can be affected is larger than any other single category. The effectiveness of the control strategies in this category are less than for most urban runoff strategies, but the low cost and large area offset the effectiveness. These strategies do not require large land areas or have adverse aesthetic values as most urban runoff strategies do.

Silviculture Runoff

Since a large part of the 208 area is heavily wooded, strategies in this category are of great importance. The potential for damage is high, but can be lessened by including practices in this category in the area's stormwater management program.

Pre-Disposal Treatments Applicable to Solid Waste Disposal Pollution

Strategies in this category should be considered when a pollution problem exists at a working landfill or a proposed landfill. Although solid waste disposal sites constitute only a small percent of the total 208 area, a problem may have a very severe effect on the local area. Also, the fact that most of these measures are preventive instead of corrective measures makes them attractive in a management program.

Disposal Treatments Applicable to Solid Waste Disposal

The concentration of pollutants and the localized damage from disposal sites make treatment of leachate a high priority problem. The effectiveness and the fact the number of sites are limited and can be controlled easier than agricultural runoff or urban runoff make them more feasible for pollution control. This category is not ranked higher because of cost and the small percentage of the 208 planning area that it affects.

Physical/Chemical Treatment of Urban Runoff

Methods under this category are very applicable for stormwater treatment and are generally very effective at suspended solids and organic materials removal. The main drawbacks are the relatively high construction, operation and maintenance costs, and the large areas of land required for facilities.

Large Scale Retention

These facilities are generally constructed for the purpose of flood reduction by temporarily storing a portion of the runoff. In reducing the peak flow rates of runoff, possible erosion hazards are reduced and indirect pollution abatement can be realized. They can require a substantial area of land, however, but generally such land is in a flood plain and not suitable for development anyway. This strategy is limited in use because of the limited number of sites for large retention basins and the adverse problem of mosquito habitat.

Cluster Housing

Although many benefits relating to pollution reduction are difficult to assess, cluster housing can have a tremendous environmental impact, simply by allowing the land to remain primarily in its natural state. In terms of total effectiveness, it has been concluded that more densely developed areas produce more pollutants than sparsely developed ones. While cluster housing does produce a greater housing density in the area of the homesites, the open area portion of a cluster housing development site reduces the overall impact potential.

Combinations of Stormwater Retention and Treatment Facilities

The attractiveness of strategies in this category lies in their dual-use capability. They are capable of providing a degree of biological treatment similar to lagoons and sedimentation, but have the added benefits of aesthetics when combined with landscaping. They must be properly maintained, however, which consists mostly of periodic sediment removal. One disadvantage is the relatively high land requirement as compared to other alternatives. Therefore, actual applications of these alternatives may be limited to semi-urban, developing urban, or rural areas.

Street Sweepers

This alternative differs from vacuum and riding sweepers in that street sweepers are used in a program that does not restrict parking during sweeping periods. As a result, only up to 50% of the solid materials may be removed if the sweeper can gain access to the curb area. Such programs in existence should remain in effect and consideration for more extensive programs should be given.

Vacuum or Riding Sweepers

Because of the considerable pollution concentration that has been associated with street litter (particularly the finer materials), the removal of this material from the watershed can represent a considerable reduction in the potential pollution of the receiving stream. Vacuum type sweeping machines have been shown to be capable of removing up to 90% of the street litter after several passes.

Shipping Activities

The control of pollution resulting from shipping activities is applicable to only a small part of the 208 area. However, the relatively low costs involved and potential of benefit to the public well-being ranks this as a category which should be given consideration.

Runoff From Mining Activities

Mining activities in the 208 area consist of such areas as lime, sand and gravel, and clay productions. These activities may have serious detrimental effects on area streams, etc. and effective methods of pollution control should be investigated.

Dredging and Fill Operations

Dredging operations affect only a small part of the 208 area but may have serious local effects if not properly controlled. Therefore, consideration should be given to methods of reducing the potential damage caused by dredging operations.

Biological Treatment of Urban Runoff

Biological treatment by itself is given a low ranking because it would not be very applicable to intermittent storm flows. Some form of detention and slow release of the flow would have to be included, but the costs of treatment would be a deciding factor.

Pervious Pavements

Where adequate soil conditions exist, pervious pavement is potentially excellent for reducing pollution and providing secondary benefits of aquifer recharge and stormwater runoff volume reduction. Use of the subsurface soil removes essentially all contaminants associated with solids, and most of the remaining contaminants are assimilated by soil bacteria. Conservative substances such as nitrates and chlorides may not be significantly removed however, and their reduction is dependent upon dilution by groundwater, or surface water should the groundwater enter a stream or lake. Although this alternative ranks reasonable high compared to others considered herein, the possible limitations should also be noted. Because of the relative slow infiltration rate of most suitable soils compared to runoff rates, some means of storing the runoff prior to infiltration will probably be necessary. Since pervious pavement is generally designed to contain only the rainfall striking the pavement, adequate retention volume can usually be provided in the subgrade aggregate. A summation of the above considerations, plus the fact that pervious pavement has a slightly adverse socio-political and socio-economic impact, leads to the low final ranking.

Streets Constructed to Natural Contours

As may be seen on the ecosystem, socio-political and socio-economic matrix almost all of the categories rate "0", meaning they are intangible and/or natural. An exception, however, is in the socio-political evaluation which rates lowest of all categories. This is because of highly adverse industrial acceptance and only slight, if any, potential enforceability. Also, as is the case with all land use planning techniques, total effectiveness is low.

Groundwater Recharge

The methods for groundwater recharge are ranked low because of the relatively high costs of implementation and unknown history of effectiveness. A great deal of research would have to be done into each specific site to determine whether or not recharge would be applicable and effective.

These various mitigating measures have resulted in improving nonpoint source pollution in other cities in the United States. But the actual means by which they occur is through some jurisdictional control. The "Control Strategies, Costs and Impacts for Nonpoint Sources" defines these as follows.

Over the years, federal, state and local jurisdictions have developed many institutional processes and procedures for controlling the rate and direction of land use and development:

1) State controls, consisting of statewide programs (such as land use, zoning, and special and regional commissions) and selective programs (such as floodplain ordinances, utility-siting regulations, strip-mining laws, wilderness preservation, and scenic rivers).

2) State criteria, consisting of statewide programs or selective programs (such as wetlands, critical areas, open-space easements, and exclusionary zoning), or both.

3) Tax incentives, such as a tax on present use or a tax with development restrictions.

4) Nonregulatory activities, such as growth and development plans, land inventories, and monitoring systems.

5) Federal laws and regulations possessing built-in land use controls.

Ordinances passed by several local governments in the United States are designed to control erosion and sediment. The general procedures called for by ordinances are usually as follows:

1) The governmental entity will not approve plans or issue a construction permit unless a builder's plans meet specified pollution abatement requirements.

2) Developers are required to submit a soil conservation plan which is reviewed and approved. A bond is required to guarantee that the approved soil conservation plan will be carried out.

3) On-site inspection by the governmental entity is made to evaluate compliance with the approved plan.

4) If the developer fails to comply, the bond is used to take needed emergency conservation measures.

5) Uncover land only when needed for immediate construction.

The restrictive nature of ordinances on the type of control technique to be used on a construction site should be avoided. It is preferable to establish water quality criteria for a given activity and require the developer to submit a plan of action for the prevention, control and/or removal of pollutants from construction activities.

Mechanisms, laws, procedures, institutes, and agencies are already established which have the personnel, expertise and authority to develop effective non-structural alternatives for controlling pollution from construction activities. The need which now exists is the establishment of interaction among the various entities to establish a workable program without adversely affecting the nation's or the local community's economy. Table VII-50 is a list of instructions, agencies and laws which are available to be integrated into a pollution control program.

Conclusion

The control of pollution from construction activities is going to necessitate a team approach on the part of contractors, engineers, developers and administrators to develop Best Management Practices. Strategies, both structural and non-structural, must be applied to best serve a particular construction activity. Table is to serve as a reference on the strategies that are useful in abating major sources of pollutants.

Institutions, Agencies, and Laws for Controlling Pollution from Construction Activities

Institutions

Council of State Governments
Agricultural Research Service
Association of State Soil Conservation Administrative Officers
National Forest Products Association
American Farm Bureau Federation
Farm and Industrial Equipment Institute
Natural Resources Defense Council
National Crushed Stone Council
National Association of Counties
National Association of Home Builders
American Landowners Association
Houston Contractors Association
Association of General Contractors
Houston Chamber of Commerce

Agencies

Houston-Galveston Area Council
Environmental Protection Agency
Corps of Engineers
Soil Conservation Service
Harris County Pollution Control Department
City of Houston Construction Division

Texas Department of Water Resources
Department of Housing and Urban Development
Federal Housing Administration
Gulf Coast Waste Disposal Authority
Harris Soil and Water Conservation District
Texas State Soil and Water Conservation Board

Laws

Federal Water Pollution Control Act Amendments of 1972
Executive Order 11507 of the Water Pollution Control Act
The River and Harbors Act of 1970
The Water Quality Improvement Act of 1970
The National Environmental Policy Act of 1969
The Clean Water Restoration Act of 1966
The Code of Federal Regualtions, Title 33, Chapter II, Part 209
The Water Quality Act of 1965
The Federal Water Pollution Act of 1956
The Model Soil Erosion and Sediment Control Law
Watershed Protection and Flood Prevention Act of 1954

CHAPTER VI- C
ECONOMICS

The recommended Waste Treatment Management Plan in most subbasins maintains existing treatment standards. In these cases, no mitigating measures have been investigated. Monitoring and enforcement programs recommended for each of the subbasins may increase research and administrative costs. These costs have not been estimated and mitigating measures not explored. However, it should be noted that in many instances the monitoring programs are recommended to verify water quality problems prior to commmitting funds to a more costly wastewater treatment regimen. The plan should have a minimal effect upon land value in the planning area and an indiscernible effect upon projected employment. Hence, no mitigating measures are explored for these effects.

The plan recommends changes to municipal wastewater treatment in three subbasins: Cypress Creek, Clear Creek-Nontidal and the Upper Houston Ship Channel. In the Clear Creek-Nontidal subbasin trial implementation of nonpoint source controls are recommended.

Cypress Creek Subbasin

Regionalization in the Cypress Creek watershed could achieve a substantial cost savings over non-regional treatment in the watershed. Because the recommendation would be implemented where economic incentives favored the measure and because non-regional treatment would not be proscribed the preferred Plan offers a possibility for savings for treatment while not imposing new costs.

Should monitoring studies indicate that higher treatment standards could achieve desired water quality standards, then treatment plants in the subbasin would be required to up-grade to the 4NA effluent set. This measure if adopted would raise treatment costs. However, if regionalization has been implemented as proposed, then treatment under the higher standards would still cost less than non-regional treatment at current permit levels.

Alternative	Water Quality Achieved	Present Worth Cost
Non-Regional Treatment, Current Permit Levels (2N)	I	$44,100,000
Semi-Regional Treatment, Current Permit Levels (2N)	I	$31,300,000
Semi-Regional Treatment, Effluent Set 4NA	III	$36,000,000

Regionalization of wastewater treatment in the Cypress Creek Subbasin as proposed in the recommended 208 Plan will achieve a cost savings both under existing permit levels and under more stringent levels if adopted.

Clear Creek-Nontidal Subbasin

The proposed more stringent municipal wastewater treatment standards for the Clear Creek-Nontidal Subbasin will increase treatments costs in the subbasin. An alternative the plan recommends for further study is interbasin transport of effluent treated at set 2. This theme is estimated to have a present worth cost less than the cost of non-regional treatment at the current permit level. However, because of the complex economic and political arrangements necessary for implementation of this concept, it was concluded that further study was necessary prior to recommending its enactment.

Alternative	Water Quality Achieved	Present Worth Cost
Non-Regional Treatment, Present Permit Levels	I	$21,000,000
Non-Regional Treatment, Effluent Set 4NPA	III	$23,400,000
Semi-Regional Treatment, Interbasin Transport	III	$16,600,000

The proposed plan recommends that trial implementation of non-point source pollution controls commence in the Clear Creek Nontidal Subbasin and that land be reserved now for future implementation of controls throughout the subbasin. Reservation of flood plain land now, either through purchase or regulation, is recommended by the plan. This action may avoid higher costs initiating non-point source control measures at a later time. The subbasin is experiencing rapid growth, urban area within the subbasin is projected to almost double from 1975 to 1995. Land values will rise making assembly of flood plain lands more expensive, if still possible. Development of these lands would require even more costly implementation of structural non-point source control measures, or acceptance of lower water quality standards in the Clear Creek Nontidal Subbasin.

The recommended program of monitoring, trials, and land reservation prior to full implementation should allow minimization of costs for non-structural measures while insuring controls will be implemented only after proven effective. Non-structural nonpoint source water pollution controls may be implemented in conjunction with non-structural flood control measures achieving a savings over separate costs for both.

Upper Houston Ship Channel

Instream aeration proposed for the Houston Ship Channel would be implemented only if water quality monitoring and modelling studies establish that stormwater related conditions do not prevent achievement of fishable and swimmable water quality. If desired water quality conditions can be achieved the proposed method is the least expensive alternative considered.

Alternative	Water Quality Achieved	Present Worth Cost
Non-Regional Treatment, Present Permit Levels	II	$18,800,000
Non-Regional Treatment, Reduce Loads to Tributary Bayous	II	$35,800,000
Non-Regional Treatment, Present Permit Levels with Instream Aeration	III	$21,300,000

The proposed Plan will have minimal indirect impacts upon land value and employment, therefore alternatives mitigating these effects have not been explored.

The proposed Water Quality Management Plan recommends changes to municipal treatment in only three subbasins. In each case water quality monitoring and modelling studies would precede implementation of treatment themes in order to insure their effectiveness. Similar testing and trials prior to implementing nonpoint source controls in the Clear Creek-Nontidal Subbasin will help establish the least cost method of control. Use of non-structural controls in this subbasin offers the possibility of coordination with flood control efforts in order to reduce total costs.

CHAPTER VI-D
WATER

Introduction

The preferred technical subplans for the 208 planning area includes several recommendations which, when implemented, will result in a lowering of dissolved oxygen concentrations and/or an increase in fecal coliform levels in some of the region's water bodies. Mitigating measures which could, if implemented, reduce these adverse water quality impacts are discussed in this chapter.

Mitigating Measures

The preferred technical subplans for the Greater Houston 208 study area provide a basis for achieving fishable/swimmable water quality as defined in the HGAC report titled, How Clean Do You Want Your Streams? Most of the preferred technical subplans in the Alternative Technical Subplans report will result directly in fishable/swimmable water quality in the stream segments addressed. However, there are some segments where either (1) a fishable/swimmable water quality goal will not be achieved, and the plan calls for lowering water quality standards, or (2) further study is required to effectively produce a final preferred subplan that will achieve fishable/swimmable water quality goals.

The mitigating measure for the first case (i.e., lowering the standards) is simply not to lower the standards in the affected segments and to allow only those waste discharges which will not cause a violation of the fishable/swimmable water quality goal to occur. Of course, the implications of this approach can be quite extensive, e.g., incorporation of advanced and exotic waste treatment technology, utilization of land disposal for treatment plant effluents, alteration of existing land use patterns, etc.

The mitigating measure for the second case (i.e., further study so that a realistic plan can be formulated) is a more complex issue. The preferred technical subplans in this class recommend a relaxation of permit requirements until such time that further study can provide more refined programs which will achieve fishable/swimmable water quality goals. For instance, recent recommendations by the Planning Advisory Council to the Executive Committee of HGAC have suggested studies to review the necessity of phosphorus removal requirements for Clear Lake, Clear Creek, and Dickinson Bayou (tidal).

It should be pointed out that several comprehensive studies dealing with such subjects as eutrophication potential, advanced water quality modeling, nonpoint source assessment, and tertiary waste treatment are called for in the Alternative Technical Subplans report. It is crucial to the success of the 208 that these studies be carried out as soon as possible and to the fullest extent. Appropriate actions must be taken in response to these studies in order to prevent further degradation of water quality in the Greater Houston area.

CHAPTER VI-E
AIR

Introduction

Although wastewater treatment facilities do not normally impact the ambient air quality significantly, the additional developments associated with such facilities can be significant direct and indirect sources of air pollutants. Wastewater treatment facilities release particulate matter and some odorous gases, which impact the areas adjacent to the wastewater treatment plant. However, growth in the vicinity of the plant (e.g., subdivisions, shopping centers, additional roads, more industries, more traffic, etc.) can be a source of particulates, nitrogen dioxide, hydrocarbons(which are the precursors of photochemical oxidants), and carbon monoxide. These additional emissions are often spread over a wide area and may cause impacts on a regional scale, instead of being restricted to a local scale.

Discussion

Potentially serious ambient air quality problems exist in the Houston-Galveston area. Federal ambient air quality standards for particulates, hydrocarbons, and photochemical oxidants are currently being exceeded in the region and AQCR No. 7 is close to non-compliance with nitrogen dioxide standards. In those areas of the region which have acceptable ambient air quality, any developments or new facilities must not contribute to significant deterioration of the ambient air quality. To insure that wastewater treatment facilities and the associated developments do not contribute to a substantial incremental increase in air pollution in the region, emission, meteorological, and ambient air quality factors must be considered.

Most of the emissions from stationary sources in the Houston-Galveston area are concentrated along the Ship Channel and along Galveston Bay, near Texas City. The ambient air quality in both of these sectors is generally poor. Mobile sources, such as automobiles, are a significant source of emissions throughout the region and are one of the major causes of the relatively high nitrogen dioxide and total suspended particulate concentrations in the central and western sections of Houston.

Hydrocarbons are emitted by both the mobile and the stationary sources in the Houston-Galveston area. Hydrocarbons react photochemically with sunlight to form photochemical oxidants, the most notable of which is ozone. When winds transport the hydrocarbons during the morning, high ozone concentrations may be experienced in downwind areas which do not necessarily have high volumes of hydrocarbons emissions. Because of these ramifications of the pollutant emissions - ambient air quality cycle, the problem is regional in nature. Emissions in one area may impact not only that sector with the emissions but also other regions that are basically free of emissions.

Consideration of Individual Subbasins

The three subbasins involved in this assessment can be evaluated with respect to the aforementioned locational factors. This matrix presents a subjective evaluation of the effects of locating the facilities in each subbasin. Factor 1 evaluates the incremental increase in ambient air quality. Factor 2 evaluates the incremental increase in emissions. Factor 3 assesses the possibilities of significant deterioration or non-compliance with regulations near or downwind from the facilities and their associated growth.

Subbasin	Factor 1	Factor 2	Factor 3
Lake Houston Subbasin (Spring Creek Basin)	Neutral	Unfavorable	Favorable
Lake Houston Subbasin (Cypress Creek Basin & Lake Houston Basin)	Favorable	Neutral	Favorable
Houston Ship Channel Subbasin (West) (Buffalo Bayou Basin)	Favorable	Favorable	Unfavorable
Houston Ship Channel Subbasin (East)	Favorable	Favorable	Unfavorable
Clear Lake Subbasin	Favorable	Favorable	Unfavorable

Summary and Conclusions

The Spring Creek watershed has a relatively low volume of pollutant emissions and relatively good ambient air quality at present. Therefore, any growth in that basin could cause significant incremental increases in emissions and noticeable local degradation of the ambient air quality. The Houston Ship Channel Subbasin and the Clear Lake Subbasin will not experience significant incremental increases in pollutant emissions or significant incremental decreases in the ambient air quality from additional wastewater treatment facilities. However, growth and new facilities in these subbasins may impact the subbasin to the north. In addition, growth will add an incremental contribution to the potential for violations of ambient air quality standards within the subbasin itself.

Subbasin	Factor 1	Factor 2	Factor 3
Houston Ship Channel Subbasin (East)	Favorable	Favorable	Unfavorable
Clear Lake Subbasin	Favorable	Favorable	Unfavorable

Summary, Conclusions, and Recommendations

Based upon the various alternatives considered, the Lake Houston watershed and the Cypress Creek watershed in the Lake Houston Subbasin appear to be best suited for development. The Spring Creek watershed has a relatively low volume of pollutant emissions and relatively good ambient air quality at present. Therefore, any developments in that basin could cause significant incremental increases in emissions and noticeable local degradation of the ambient air quality. The Houston Ship Channel Subbasin and the Clear Lake Subbasin will not experience significant incremental increases in pollutant emissions or significant incremental decreases in the ambient air quality from additional wastewater treatment facilities. However, developments and new facilities in these subbasins may impact the subbasin to the north. In addition, development will add an incremental contribution to the potential for violations of ambient air quality standards in the vicinity of the development, or within the subbasin itself.

Thus, a regional ambient air quality problem may be created or abetted by locating the wastewater treatment facilities within either of these two subbasins. The far western section (Buffalo Bayou Basin) of the Houston Ship Channel Subbasin could be acceptable for the location of such facilities from an air quality standpoint. However, the Lake Houston Basin or the Cypress Creek Basin appear to be best for the implementation of the 208 Plan from an air quality standpoint.

CHAPTER VI-F
PUBLIC HEALTH

The preferred technical subplans for the Houston-Galveston 208 planning area satisfy public health requirements as they pertain to water borne pathogenic organisms. Hence, no mitigating measures for the adverse effects of the alternative technical subplans with respect to public health need be developed. However, as previously mentioned, the preferred technical subplans address only dissolved oxygen and fecal coliform levels in the 208 planning area. There also may exist additional threats to public health in the area due to the undetected presence of some other potentially harmful substances such as those identified in Chapter II-F of this report. Hence, it would appear desirable to plan and implement an organized program to determine the possible levels of hazardous materials in the Greater Houston area waters at present and in the future with and without the proposed 208 project. Appropriate steps to alleviate any possible public health effects should be taken if such substances are found.

CHAPTER VI-G
BIOLOGY

The recommended 208 Plan requires that studies be conducted that will accurately establish treatment requirements and levels. These studies will permit a more thorough review of impacts on biological elements and will result in a better understanding of interactions existing between biological and water quality conditions. The development of mitigating measures can best be determined at that stage in the planning process.

There are several biological aspects of the recommended 208 Plan which require the consideration of mitigating measures. These aspects include the classification of stream segments as not capable of attaining fishable/swimmable standards by 1983, the elimination of current treatment requirements and the maintenance of current treatment levels in streams with severely degraded water quality conditions. All of these actions will require site-specific analysis of biologic impacts prior to implementation of the recommended plan.

There are three recommendations for mitigating measures which will be considered as elements of this biological assessment. These measures are mentioned in general and apply to all stream segments within the 208 area.

1. Further Studies - Studies recommended in the 208 Plan should be completed as soon as possible. Due to the number of recommended studies this requirement may be difficult considering manpower and funding prospects. The time-frame necessary for the completion of these studies could extend through several years. The failure to establish proper control levels during this period could result in significant damage to biological resources.

2. Treatment Levels - Current treatment levels and special requirements should not be decreased or eliminated before specific information on the necessity of these criteria can be established. Special controls or treatment levels may or may not have been established unnecessarily. However, to assume that these controls are unnecessary while recommending further studies to determine this necessity may be unjustified. This method of action could result in further loss of environmental quality.

3. Classification of Stream Segments - Classification of stream segments as not capable of meeting fishable/swimmable criteria should be done only after a thorough analysis of potential impacts on biological resources. Those segments which have been recommended as non-attainment areas currently possess poor ecological conditions. The

impact of this classification would therefore appear to be insignificant. However, when compared to the potential ecological condition of these streams under fishable/swimmable conditions, the effect of classification could be considered severe. Reclassification to a lower water quality standard should be completed only after thorough consideration of all possible actions and a comparison of the relative impacts of those actions.

CHAPTER VII
ASSESSMENT METHODOLOGY

Typically, in the preparation of any 208 plan, a large number of variables are investigated and analysed. It is frequently difficult to perform meaningful comparisons and evaulation of these variables because of the large number of possible combinations. One method of simplifying the analysis process is the use of an environmental matrix procedure. The matrix approach utilizes a point rating system to evaluate the relative values of specific environmental impacts associated with individual actions. The matrix methodology is used in this environmental assessment of the selected plan.

In applying the environmental matrix to the impacts associated with the proposed 208 Areawide Waste Treatment Management Plan, the following set of selected environmental parameters have been defined and related to projected environmental changes. These environmental parameters are listed below:

Environmental Parameters

Fish Fauna
Invertebrates and Benthic Communities
Rare and Endangered Species - Aquatic
Marshland Wildlife Habitat
Waterfowl Populations
Nursery and Spawning Grounds
Aquatic Plant Communities
Ecologically Sensitive
Wildlife
Vegetation
Natural Areas
Rare and Endangered Species - Terrestrial
Agriculture
Dissolved Oxygen
Fecal Coliform
Air Quality
Emissions
Visibility
Meteorology
Land Use Nopoint
Land Use Point Source
Aesthetics
Archeology

The environmental matrix approach involves the aggregation of numerous primary and secondary impacts into a single representative value called the "environmental impact unit" (EIU). In this study, a seven-point EIU system has been used to provide adequate numerical distinction among the anticipated environmental changes associated with the selected environmental parameters. Hence, for each environmental parameter of concern, EIU values from +2 to -4 have been used to denote the entire range of potential impacts, i.e., from expected positive improvements (+2) to no expected change (0) to the creation of significant adverse impacts, (4). In the assessment of non site-specific point and nonpoint pollution control alternatives, it was felt that a system with finer resolution would be more effective to differentiate between the slight changes in receiving water quality resulting from discharged effluents at various treatment levels.

In applying the environmental matrix approach, the cumulative magnitude of all impacts resulting from a given action is represented by the composite EIU number. The number itself is insignificant; it is useful only as a means for comparison in a "before-after" context. This assessment methodology is based on a comparison of the state of a defined environmental parameter (site-specific or otherwise) at the present time with the predicted state of the parameter after a certain elapsed time period. Present time is actually taken as the most recent period for which enough environmental data are available to establish a "state" of the parameter baseline. The length of the time period elapsed between system comparisons can be specified by the impact assessment analyst to reflect the quantity and quality of available data collection programs, the planning horizons being investigated, and/or the temporal patterns of important ecological processes.

With reference to the actual EIU values assigned for each environmental parameter, three points should be made. First, the value range is biased toward assessing the detrimental impacts of each alternative. A small allowance has been made for positive impacts, but they are rare, for a given parameter.
As long as the range of value for each parameter is utilized consistently throughout the evaluation process, a valid means of alternative comparison is maintained.

Second, weighting of the parameters has been developed to allow for one being more or less significant than the others. Weighting is reflected in the range of scores.

Third, the valuing method used to assess the impacts is somewhat simple and unrefined and, occasionally, two alternatives may have the same value for a given parameter even though there is a perceived difference between the anticipated impacts. However, such apparent discrepancies do not undermine the validity of the methodology. The range of values simply cannot be wide enough to reflect every difference and still be practical for assessing such a large number of alternatives. As long as all values are applied consistently, the methodology is believed to validly assess the alternatives at the level of comparison intended.

Water Quality and Biological Impact Assessments

The environmental matrix approach using environmental impact units (EIU) to differentiate between impact magnitudes provides a useful framework for comparison of alternatives regarding treatment facility location and different levels of wastewater treatment. However, such an approach must be based on sound ecological principles. This is essential since the evidence for environmental disruption or damage is often not as straight-forward as a direct comparison between an observed or predicted value and an established standard.

The magnitude of water quality impacts due to the implementation of various wastewater treatment levels varies depending upon the quantity and quality of effluent discharges, the natural assimilative capacity of receiving water bodies, the prevailing flow conditions (such as seasonal flow changes, tidal circulation, etc.), and the resident flora and fauna. In this study, projected water quality effects associated with alternative waste controls strategies have been demonstrated using computer modeling of the respective receiving water bodies. There models were applied, and operated to evaluate the dissolved oxygen response of water bodies in the planning area subject to municipal and industrial waste loadings. Specifically models were applied to three sub-basins (Lake Houston, Clear Lake, Houston Ship Channel) and runs were made to simulate BOD/DO variations under a range of loading conditions.

Since oxygen-demanding organic matter is a primary component of effluents from municipal and industrial wastewater treatment facilities, properly-calibrated BOD/DO steady-state low flow models can be effective tools for analyzing impacts due to point source discharges. Of course, it would be even more meaningful if other important water quality parameters such as nutrients and coliform bacteria also were included in the modeling effort. Environmental changes induced by related constituents other than BOD/DO has been inferred from proposed growth activities, mitigating measures and known water quality-biota relationships.

Computer modeling only serves to alert the analyst to potential impacts on the biota and other environmental characteristics generated by the nature of effluent discharges. Determining slight pollution-induced changes in the population size of a particular fish species, the ability of the aquatic habitat to support a viable community, or the abundance of nuisance plants or algae growths due to nutrient enrichment all require subjective analyses. They must be based on the widest possible assemblage of baseline data and on projections associated with proposed management activities and strategies.

Most of the basic water quality-biota relationships affecting the study area's waterways have been discussed. In evaluating the environmental effects of the proposed plan, major emphasis has been placed on dissolved oxygen because of its direct relationship to carbaonaceous waste discharges and the availability of simulated DO results from the modeling effort. A long history of observation and experimentation has delineated the physiological effects of dissolved oxygen levels on aquatic organisms and the ecosystem changes due to differential DO stress levels for various biota groups. However, because of the synergistic and/or antagonistic effects of complex and interrelated ambient environmental conditions, clear-cut relationships between other single chemical constituents and specific organisms are not commonplace in aquatic ecology.

Land Use and Socio-Economic Assessment

The land use and socio-economic parameters were assessed by utilizing the data compiled by H-GAC and were analysed for this report. The EIU values assigned during the evaluation process particularly reflect the influence of secondary environmental impacts. For example, the secondary impact of altered land use patterns due to induced growth is considerably more important than the altered land use patterns resulting from the physical presence of a wastewater treatment facility, and shows in the terrestial aspects of the impact matrix.

EIU Value Tables

The types of considerations utilized to arrive at specific EUI values for each of the environmental parameters are outlined in the following tables. The criteria developed for this evaluation are based solely on environmental considerations. Cost effectiveness and the implementability of alternatives is considered in the evaluation scheme, but is done so subjectively.

TABLE VII-1 AQUATIC BIOLOGY MAGNITUDE OF ENVIRONMENTAL IMPACT UNITS

Parameter of Concern	Environmental Impact Unit Range						
	0	1	2	3	4	5	6
1. Fish Fauna	Permanent increases in water quality conditions to levels above fishable/swimmable criteria	No expected changes in freshwater fish populations expected due to water quality below fishable/swimmable criteria	No change from current conditions	Possible impact on nursery habitat due to habitat removal, infrequent violations of water quality standards	Periodic violations of water standards (D.O. 4 mg/l)may affect juvenile organisms; impacts discernible during worst case hydrologic conditions	Numerous D.O. violations under low flow conditions. Toxic substances in the sediments have undetermined impact on resident biota	Low D.O. and presence of toxic substances create poor environment for both juvenile and adult biota. Habitat usage likely to decrease drastically due to degraded water quality
2. Invertebrates and benthic communities	Benthic BOD loadings removed and water quality conditions exceed fishable/ swimmable	No anticipated impacts on the invertebrate fauna due to water quality conditions below fishable/ swimmable crireria	No change from current conditions	Water quality constituents, such as suspended solids from site construction, may increase somewhat. Increased organic matter may actually be beneficial	Periodic water quality problems due to hydrologic conditions, increased sediment deposition during floods, low D.O. during low flow periods or salt wedge enchroachment	Low dissolved oxygen (2 mg/l) near bottom may favor nuisance species over economically valuable ones. High coliform levels may periodically contaminate shellfish	Low D.O. and high toxics content of sediment adversely affect the benthic fauna. Poor water quality along shorelines and marshes restrict valuable invertebrate habitat. Coliform levels are too high to permit harvest
3. Rare and endangered species (aquatic)	Populations of endangered organisms increase and man related interferences eliminated	No expected impacts on aquatic rare and endangered species due to water quality below fishable/swimmable criteria	No change from current conditions	Effluent discharges do occur within the known habitat of rare and endangered species; magnitude of effects unknown	Periodic impacts due to water quality changes within known home range (current distribution) direct effect on sensitive species unknown	Adverse water quality conditions anticipated in favored habitat. Short-term stresses, such as D.O. depression, most likely to portion of population	Poor water quality conditions to occur in spawning/ breeding habitat of scarce species; pesticides and other toxic substances pose a threat to the species viability
4. Marshland wildlife habitat	Marshlands preserved from man related interferences	Water quality changes not expected to affect marshland habitat and its nonaquatic residents	No change from current conditions	Effluent discharges are likely to alter water quality conditions in marshes, indeterminent effects	Site construction will temporarily remove productive habitat from use by wildlife. Water quality changes due to effluent discharges likely to aggravate natural environmental extremes (i.e., diurnal D.O. fluctuations)	Water quality degradation reduces population of favored aquatic food chain orgnaisms. Primary impacts of site construction and secondary effects of urbanization or land use change likely to reduce available wildlife habitat permanently	Discharges may contain toxic materials that can enter terrestrial food chains via contaminated aquatic organisms

AQUATIC BIOLOGY

TABLE VII-1 MAGNITUDE OF ENVIRONMENTAL IMPACT UNITS
(Continued)

Parameter of Concern	Environmental Impact Unit Range						
	0	1	2	3	4	5	6
5. Waterfowl populations	Natural population rise established by habitat preservation	No water quality effects on waterfowl habitat food supply, or birds themselves	No change from current conditions	Site construction may affect localized habitat. Some increased turbidity-may reduce aquatic plant productivity or distribution	Construction removes usable habitat permanently. Increased nutrient levels may slightly alter species composition from rooted aquatics to planktonic form	Increased nutrient levels and associated poor water quality favor blue-green algae mats, nuisance floating plants, or other non-nutritive plants. Food organisms for diving birds may be adversely affected by poor water quality	Favored food organisms and plants used by waterfowls adversely impacted by ambient water quality. Potential for bioaccumulation in waterfowl due to high levels of toxic constituents in preferred foods
6. Nursery and spawning grounds	Permanent increases in water quality to levels above fishable/swimmable criteria	No discernible impact of discharges on nursery or spawning habitat	No change from current conditions	Increased turbidity may cause siltation at spawning sites-predator-prey interactions affected by limited visibility. Organic insects and nutrient loads have little direct impact on fishes	Occasional depressions of D.O. below 5 mg/l. Water quality conditions might affect essential food chain organisms (i.e., aquatic insects)	Periodic depressions of D.O. below 4 mg/l may alter species composition; rough-fish favored over gamefish	Poor water quality conditions (2 mg/l D.O.) may inhibit reproductive activities (i.e., courtship behavior or spawning migrations). Toxics, coliforms, and tainting substance may contaminate commercial populations. Stress conditions favor rough fish populations
7. Aquatic plant communities	Natural conditions permanently established in natural areas with elimination of man related interferences	No impacts on aquatic vegetation expected	No change from current conditions	Discharges may reach sensitive areas under unusual hydrologic regimes. Some turbidity may occur	Diluted effluent discharges reach sensitive areas. Predominance of organic pollutants may slightly depress ambient D.O. levels	Only slight dilution of pollutants due to poor hydrologic flushing may adversely impact benthic and sessile organisms	Sensitive areas receive toxic pollutants in settled sediment. Undiluted effluents and the resultant water quality degradation (low D.O. levels) may enhance the impact of other constituents. Pollutants may become incorporated into local food chains and affect sensitive resident biota
8. Natural areas (aquatic)	Permanent increases in water quality to levels above fishable/swimmable criteria	Effluent discharges are not expected to reach sensitive habitats. No D.O. depression nor water quality impacts	No change from current conditions	Increased turbidity (temporary) from site construction may limit light penetration, but increased nutrient availability from discharges should actually increase local productivity	Water quality conditions may speed up extraphication by encouraging species replacement in local flora	Periodic, localized problems with nuisance plant growths-especially during inadequate flushing of water courses. Hydrophilic shoreline vegetation may increase dramatically in response to enriched sediments	Poor water quality (including high nutrients) favors glue-green algae mats. Loss of submerged, rooted vegetation essential to local food chains due to competition with nuisance plants

PUBLIC HEALTH AND AIR

TABLE VII-1 MAGNITUDE OF ENVIRONMENTAL IMPACT UNITS

Parameter of Concern	Environmental Impact Unit Range 0	1	2	3	4	5	6
14. Dissolved Oxygen (Public Health)	Undetermined major improvements on local surface water quality due to changes in point and nonpoint source discharges.	Undetermined minor improvements on local surface water quality due to changes in point and nonpoint source discharges.	No significant change in ambient water quality expected in the area's surface water bodies	Undetermined minor impact on local surface water quality due to changes in point and nonpoint source discharges	Depression of D.O. levels to near local stream standards may occur under unusual flow regimes (either low flow, runoff conditions or poor flushing conditions)	D.O. levels may decrease periodically below stream standards during normal flow due to discharges; other water quality parameters may also exceed standards or fishable/swimmable criteria	D.O. to exceed stream standards under most flow regimes; high levels of nutrients may produce highly eutrophic system, or high levels of toxics present in sediments with low D.O.
15. Fecal Coliform (Public Health)	Absence of detectable fecal coliform organisms	Major reduction in fecal coliform level to a better water quality than achieved by fishable/swimmable criteria	Fecal coliform level equivalent to fishable/swimmable criteria	Minor increase in level of fecal coliform organisms above the fishable/swimmable level	Major increase in level of fecal coliform organisms above the fishable/swimmable level	Level of fecal coliform organisms that would threaten public health not fit for contact recreation	Levels of fecal coliform organisms that would make segment unfit for non-contact recreation
16. Air Quality 17. Emissons 18. Visibility 19. Meteorology	A noticeable improvement in the ambient air quality is likely within the subbasin. Pollution emissions will be reduced. Undesirable small-scale meteorological features within the subbasin will be minimized	Small undetermined improvements in the ambient air quality of the subbasin are possible. Pollutant emissions may be reduced slightly	Negligible changes in ambient air quality, pollutant emissions, or meteorology will occur in the subbasin due to the project activities	Undetermined minor negative impacts on the ambient air quality, emissions, or meteorology in the subbasin at site-specific locations are possible	Potential local ambient air quality degradation and visibility reduction due to the project and its associated growth patterns are likely. Some noticeable effects on meteorology are possible on a local scale	Ambient air quality degradation and visibility reduction throughout the subbasin because of the project and its related growth patterns are likely. Ambient air quality standards may be exceeded occasionally. Some effects on meteorology are likely on a large scale	Ambient air quality and visibility reduction is expected on a regional basis. Significant deterioration of the ambient air

TERRESTRIAL BIOLOGY

TABLE I MAGNITUDE OF ENVIRONMENTAL IMPACT UNITS

Parameter of concern	Environmental Impact Unit Range						
	0	1	2	3	4	5	6
9. Terrestrial Wildlife	Actions taken to actively preserve vetegation	No impacts on wildlife populations or habitats	No change from current condition	Temporary displacement of wildlife population	Long term displacement of wildlife populations resulting in significant loss	Permanent, small scale loss of wildlife habitat resulting in local decline in wildlife varying in capacity	Permanent loss of wildlife habitat resulting in total loss of wildlife population
10. Terrestrial Vegetation	Actions taken to preserve vetegation	No impact on terrestrial vegetation	No change from current condition	Limited-short term distribution of vegetative cover due to construction: prairies	Limited-long term disruption of vegetative cover in construction: forests	Major-long term disruption of vegetative cover in parkland development	Permanent loss of vegetative cover due to residential, commercial, or industrial development
11. Natural Areas-Terrestrial	Natural areas preserved	No impacts on natural areas	No change from current condition	Temporary disruption of areas adjacent to natural areas. Little impace on water quality conditions	Partial and temporary disturbance of natural areas and associated water quality	Partial and permanent loss of surface area and water quality of natural areas	Large scale permanent loss of surface area or major loss of water quality with long range impacts on benthic BOD
12. Rare and Endangered Species-Terrestrial	Actual habitats preserved	No impacts on population or habitats of endangered species	No change from current condition	Temporary displacement of endangered animals due to small scale construction activities	Temporary and partial disruption of habitats for endangered organisms	Small scale, permanent loss of habitats and decline in populations of rare and endangered organisms	Permanent large scale disruption of habitats and major decline in population of endangered organisms
13. Agricultural	Incentives in force to allow agricultural land use confirmation	No impact on agricultural land use area	No change from current condition	Limited and temporary disruption of agricultural areas	Loss of small areas or adverse changes in tax rate	Loss of moderately sized areas or adverse changes in tax rate which make agricultural activities significantly less economically viable	Permanent loss of large agricultural land use areas due to displacement or tax rate

LAND USE, AESTHETICS AND ARCHEOLOGY

TABLE VII-1 MAGNITUDE OF ENVIROMNENTAL IMPACT UNITS

Parameter of Concern	Environmental Impact Unit Range						
	0	1	2	3	4	5	6
20. Land Use Point Source Pollution	Significant improvement in surface water quality due to preferred plan	Preferred plan actually improves water quality of streams at point source	No significant change in ambient water quality expected in the area's surface water bodies as a result of proposed plan	Undetermined minor impact in area of point source pollution	Partial or temporary disturbance of water quality from a point source standpoint	Small scale but recoverable loss to water quality due to point source and partial permanent loss to stream ecosystem	Permanent loss of water quality and long range impacts on stream ecosystem
21. Land Use Nonpoint Source Pollution	Significant improvement to stream due to mitigating measure in the recommended plan	Small improvement to water quality due to local runoff control measures and reduced pollutant loading	No determinable impact or improvement to water quality due to nonpoint source runoff	Undetermined minor impact in stream due to urban runoff	Partial or temporary disturbance of water quality from nonpoint source runoff	Small scale loss to water quality and stream ecosystem, recoverable with significant effort	Permanent loss of water quality and long range impacts on the overall ecosystem of the watershed
22. Aesthetics	Large scale program to preserve key features	Small scale action to save key features	No change from current condition	Undetermined minor impact to key features	Partial loss of key aesthetic features	Small scale loss of key aesthetic features	Permanent loss of entire key aesthetic features
23. Archeology	Archeological sites saved permanently	Archeological sites temporarily saved	No sites encountered	Undetermined minor impact to recorded sites	Partial loss of less important sites	Small scale loss of important registered sites	Permanent loss of major registered sites

PRIMARY IMPACT

			LAKE HOUSTON SUBBASIN			CLEAR LAKE SUBBASIN						HOUSTON SHIP CHANNEL SUBBASIN									
												EASTERN PORTION									WESTERN PORTION
			SPRING CREEK 1008	CYPRESS CREEK 1009	LAKE HOUSTON 1002	CLEAR CREEK NONTIDAL 1102	CLEAR CREEK TIDAL 1101	CLEAR LAKE 2425	ARMAND BAYOU (UNCLASSIFIED)	DICKINSON BAYOU NONTIDAL 1104	DICKINSON BAYOU TIDAL 1103	TURNING BASIN 1007	TURNING BASIN TO SAN JACINTO RIVER 1006	SAN JAC. RIVER TO MORGANS PT. 1005	SAN JAC. R.- TIDAL 1001	TABBS BAY 2426	SAN JACINTO BAY 2427	BLACK DUCK BAY 2428	SCOTT BAY 2429	BURNETT BAY 2430	(UNCLASSIFIED) BUFFALO BAYOU
EXISTING CONDITIONS																					
BIOLOGY	AQUATIC	FISH FAUNA	3	3	3	3	4	4	5	5	5	6	6	3	4	3	3	3	3	3	3
		INVERTEBRATES AND BENTHIC COMMUNITIES	3	4	3	4	4	4	5	5	5	6	6	3	4	3	3	3	3	3	3
		RARE AND ENDANGERED SPECIES	3	3	4	4	3	3	3	3	5	3	3	3	4	3	3	3	3	3	3
		MARSHLAND WILDLIFE HABITAT	3	3	3	3	3	3	5	3	3	3	3	3	4	3	3	3	3	3	3
		WATERFOWL POPULATIONS	3	3	3	4	4	5	4	4	4	3	3	3	4	3	3	3	3	3	3
		NURSERY AND SPAWNING GROUNDS	3	3	3	3	4	3	4	5	6	3	3	5	5	5	5	5	5	5	5
		AQUATIC PLANT COMMUNITIES	3	3	3	3	2	3	4	4	5	4	4	3	3	3	3	3	3	3	3
		ECOLOGICALLY SENSITIVE	4	4	4	2	2	3	3	4	5	4	5	3	4	3	3	3	3	3	3
	TERRESTRIAL	WILDLIFE																			
		VEGETATION																			
		NATURAL AREAS																			
		RARE AND ENDANGERED SPECIES						INSUFFICIENT DETAIL TO ALLOW EVALUATION													
		AGRICULTURE																			
WA	PUBLIC	DISSOLVED OXYGEN	2	3	2	2	2	2	3	3	3	3	3	3	2	3	3	3	3	3	3

BIOLOGY	AQUATIC	HABITAT	3	3	3	3	3	3	5	3	3	3	3	3	4	3	3	3	3	3	3
		WATERFOWL POPULATIONS	3	3	3	4	4	5	4	4	4	3	3	3	4	3	3	3	3	3	3
		NURSERY AND SPAWNING GROUNDS	3	3	3	3	4	3	4	5	6	3	3	5	5	5	5	5	5	5	5
		AQUATIC PLANT COMMUNITIES	3	3	3	3	2	3	4	4	5	4	4	3	3	3	3	3	3	3	3
		ECOLOGICALLY SENSITIVE	4	4	4	2	2	3	3	4	5	4	5	3	4	3	3	3	3	3	3
	TERRESTRIAL	WILDLIFE																			
		VEGETATION																			
		NATURAL AREAS																			
		RARE AND ENDANGERED SPECIES						INSUFFICIENT DETAIL TO ALLOW EVALUATION													
		AGRICULTURE																			
WATER AND PUBLIC HEALTH		DISSOLVED OXYGEN	2	3	2	2	2	2	3	3	3	3	3	3	2	3	3	3	3	3	3
		FECAL COLIFORM	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AIR		AIR QUALITY																			
		EMISSIONS						INSUFFICIENT DETAIL TO ALLOW EVALUATION													
		VISIBILITY																			
		METEOROLOGY																			
LAND USE Non Point																					
LAND USE Point Source			2	1	2	2	2	3	1	2	2	1	1	3	2	2	2	2	2	2	2
AESTHETICS																					
ARCHEOLOGY			3	4	4	4	4	4	4	2	2	3	3	2	3	3	3	3	3	3	3

SECONDARY IMPACT

				BIOLOGY													
				AQUATIC									TERRESTRIAL				
			EXISTING CONDITIONS	FISH FAUNA	INVERTEBRATES AND BENTHIC COMMUNITIES	RARE AND ENDANGERED SPECIES	MARSHLAND WILDLIFE HABITAT	WATERFOWL POPULATIONS	NURSERY AND SPAWNING GROUNDS	AQUATIC PLANT COMMUNITIES	FRESHWATER FISH FAUNA	ECOLOGICALLY SENSITIVE	WILDLIFE	VEGETATION	NATURAL AREAS	RARE AND ENDANGERED SPECIES	AGRICULTURE
HOUSTON SHIP CHANNEL SUBBASIN	WESTERN PORTION	(UNCLASSIFIED) BUFFALO BAYOU															
	EASTERN PORTION	BURNETT BAY 2430															
		SCOTT BAY 2429															
		BLACK DUCK BAY 2428															
		SAN JACINTO BAY 2427															
		TABBS BAY 2426															
		SAN JAC. R.-TIDAL 1001															
		SAN JAC. RIVER TO MORGANS PT. 1005															
		TURNING BASIN TO SAN JACINTO RIVER 1006															
		TURNING BASIN 1007															
CLEAR LAKE SUBBASIN		DICKINSON BAYOU TIDAL 1103		INSUFFICIENT DETAIL TO ALLOW EVALUATION			INSUFFICIENT DETAIL TO ALLOW EVALUATION							INSUFFICIENT DETAIL TO ALLOW EVALUATION			
		DICKINSON BAYOU NONTIDAL 1104															
		ARMAND BAYOU (UNCLASSIFIED)															
		CLEAR LAKE 2425															
		CLEAR CREEK TIDAL 1101															
		CLEAR CREEK NONTIDAL 1102															
LAKE HOUSTON SUBBASIN		LAKE HOUSTON 1002															
		CYPRESS CREEK 1009															
		SPRING CREEK 1008															

OLOGY	AQUATIC PLANT COMMUNITIES																			
	FRESHWATER FISH FAUNA																			
	ECOLOGICALLY SENSITIVE																			
TERRESTRIAL	WILDLIFE																			
	VEGETATION				INSUFFICIENT DETAIL TO ALLOW EVALUATION															
	NATURAL AREAS																			
	RARE AND ENDANGERED SPECIES																			
	AGRICULTURE																			
WATER AND PUBLIC HEALTH	DISSOLVED OXYGEN				INSUFFICIENT DETAIL TO ALLOW EVALUATION															
	FECAL COLIFORM																			
AIR	AIR QUALITY	5	5	5	6	6	6	6	6	6	4	4	4	4	4	4	4	4	4	6
	EMISSIONS	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	4
	VISIBILITY	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	METEOROLOGY	3	3	3	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
LAND USE Point Source																				
LAND USE Non Point		2	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3
AESTHETICS					INSUFFICIENT DETAIL TO ALLOW EVALUATION															
ARCHEOLOGY																				

APPENDIX

LAND USE

LAND USE PROJECTIONS
TOTAL CHANGE

Tract	Single Family		Multi-Family		Commercial		Industrial		Open		Agriculture		Vacant		Other	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
121	(4.0)	(57)	51.3	51	(21.7)	(3)	(21.6)	(46)	0	0	—	—	(4.0)	(58)	0	0
122	(36.9)	(48)	20.8	78	16.5	33	0.0	0	—	—	—	—	(3.9)	(67)	0	0
123	(15.1)	(33)	0.0	0	6.8	15	12.9	5	0	0	—	—	(4.6)	(90)	0	0
124	(93.8)	(49)	71.3	365	26.3	12	—	—	0	0	—	—	(3.9)	(65)	0	0
125	(12.2)	(61)	13.5	119	0.0	0	—	—	—	—	—	—	(1.3)	(62)	0	0
126	(65.7)	(43)	25.8	42	39.9	99	—	—	0	0	—	—	—	—	0	0
201	(68.0)	(21)	79.2	288	10.8	23	0.0	0	0	0	—	—	(22.0)	(64)	0	0
202	(21.7)	(6)	(103.5)	200	50.3	30	10.1	0	0	0	—	—	(142.3)	(77)	0	0
203	(139.8)	(19)	113.3	800	29.1	22	0.0	0	0	0	—	—	(23.0)	(77)	0	0
204	(25.1)	(12)	33.0	500	13.7	120	4.0	10	0	0	—	—	(5.6)	(64)	0	0
205	10.8	2	10.2	30	0.0	0	42.1	23	—	—	—	—	(63.1)	(80)	0	0
206	(47.8)	(11)	77.4	48	0.0	0	12.0	7	0	0	—	—	(45.4)	(78)	0	0
207	36.7	6	51.2	145	24.7	13	335.0	30	0	0	—	—	(146.1)	(65)	0	0
208	100.7	13	75.2	123	0.0	0	80.7	18	0	0	—	—	(256.6)	(59)	0	0
209	12.0	21	7.3	49	.1	0	156.5	19	—	—	—	—	(179.6)	(60)	0	0
210	32.7	4	29.9	253	41.2	36	159.2	38	0	0	—	—	(263.0)	(30)	0	0
211	(17.2)	(2)	(3.6)	(45)	(2)	(0)	175.0	34	0	0	—	—	(153.0)	(6)	—	—
212	2.8	0	.3	2	.2	0	—	—	0	0	—	—	(1.5)	(2)	—	—
213	822.2	99	271.2	223	143.0	108	(23.7)	(34)	167.4	101	—	—	(1380.2)	(59)	0	0
214	1033.0	212	—	—	224.1	711	130.4	14	53.1	174	—	—	(1471.2)	(63)	30.6	61
215	4933.0	32	9.9	54	70.0	51	73.1	34	0	0	—	—	(646.4)	(60)	0	0
216	367.1	66	28.4	1136	125.0	21	0.0	0	0	0	—	—	(417.0)	(54)	—	—
217	63.3	8	0.0	0.0	17.9	22	—	—	0.0	0	—	—	(81.3)	(36)	—	—
218	106.4	15	105.1	153.0	89.1	29	68.4	412	0.0	0	—	—	(351.3)	(82)	0	0
219	45.0	9	31.2	147.0	31.6	25	43.7	99	0.0	0	—	—	(151.6)	(63)	0	0
220	86.2	12	46.9	152.0	27.7	25	11.7	183	16.5	63	—	—	(189.0)	(43)	—	—
221	1.6	0	—	—	0.0	0	—	—	0.0	0	—	—	(1.6)	(3)	0	0
222	120.0	15	0.0	0.0	3.7	4	0	0	.8	3	0	0	124.0	50	0	0
223	12.0	1	.5	1.0	3.7	4	0	0	.8	3	—	—	(124.0)	(50)	0	0
224	391.7	27	43.5	116.0	123.0	42	0	0	5.2	260	0	0	(563.0)	(59)	0	0
225	101.9	8	0.0	0.0	49.4	22	0	0	0.0	0	—	—	(151.3)	(45)	—	—
226	683.1	94	100.9	155.0	180.0	126	—	—	6.9	6	—	—	(970.9)	(26)	—	—
227	384.8	58	8.3	54.0	65.6	68	265.9	169	0.0	0	—	—	724.5	(42)	—	—
228	193.6	53	10.3	476.0	109.8	84	205.0	93	2.2	37	0	0	854.7	(17)	0	0
229	251.2	54	6.0	600.0	104.0	189	210.0	190	.9	90	320	7	(250.0)	(100)	0	0
230	299.1	12	175.4	390.0	121.0	42	0.0	0	8.1	14	0	0	(6025.0)	(33)	0	0
231	8.6	1	—	—	11.4	10	3.6	(80)	0.0	0	—	—	(16.4)	(80)	0	0
232	0.0	0	151.1	549.0	7.1	3	162.1	14	0.0	0	—	—	(320.4)	(35)	0	0
233	50.0	27	0	0	2.2	2	725.0	111	.5	50	—	—	(776.7)	(14)	0	0
234	56.4	9	17.2	138.0	3.4	2	0.0	0	.8	5	—	—	(77.5)	(11)	0	0
235	119.1	13	13.2	19.0	7.0	7	400.0	59	1.4	1	0	0	539.0	(9)	0	0
236	458.5	60	86.4	265.0	12.0	14	600.0	960	2.7	5	—	—	1143.5	13	0	0
237	47.4	39	2.5	250.0	2.4	240	0.0	0	.5	1	0	0	55.0	(1)	0	0
238	140.5	33	29.9	43.0	90.1	328	650.0	185	1.7	17	0	0	(157.0)	(4)	0	0
239	81.0	11	4.4	29.0	69.3	66	0	0	1.0	10	—	—	(157.0)	(5)	0	0
240	858.3	44	454.0	58.0	43.6	15	—	—	17.3	115	—	—	(926.8)	(34)	0	0
241	386.7	74	0.0	0.0	135.6	169	0	0	2.4	2	—	—	(323.5)	(9)	0	0
242	200.0	551	0.0	0.0	1.1	5	0	0	.2	20	0	0	(90.0)	(2)	0	0

Tract	Single Family		Multi-Family		Commercial		Industrial		Open		Agriculture		Vacant		Other	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
243	50.0	14	0	0	115.4	128	260	10	.1	0	0	0	(425.5)	(4)	0	0
244	711.0	192	6.3	630	9.4	22	—	—	3.4	340	0	0	(789.6)	(13)	0	0
245	274.9	37	30.5	26	106.1	41	0	0	3.6	25	—	—	(413.0)	(6)	0	0
246	172.4	689	0	0	1.3	130	—	—	.3	30	0	0	(172.0)	(7)	0	0
247	797.3	996	0	0	7.0	12	0	0	1.6	160	0	0	(805.0)	(8)	0	0
248	39.0	24	—	—	2.9	6	0	0	.4	0	—	—	(39.0)	(0)	0	0
249	790.1	125	425.0	77	40.1	72	0	0	9.1	4	—	—	(880.0)	(5)	0	0
250	38.8	18	—	—	1.4	140	—	—	.3	30	0	0	(39.0)	(0)	0	0
251	124.5	25	—	—	5.4	4	0	0	1.2	20	0	0	(128.0)	(2)	0	0
252	198.7	55	—	—	1.2	4	—	—	.3	4	0	0	(178.0)	(12)	0	0
253	168.7	51	0	0	0	0	0	0	1.7	0	0	0	(176.5)	(1)	0	0
254	75.9	32	—	—	—	—	115	25	.7	0	0	0	(193.5)	(4)	0	0
255	52.7	21	0	0	2.3	1	—	—	.5	50	0	0	(53.0)	(1)	0	0
256	166.2	174	—	—	1.0	2	0	0	.2	20	0	0	(218.0)	(8)	0	0
257	347.4	267	—	—	1.9	19	0	0	.4	40	0	0	(566.0)	(69)	0	0
258	213.8	13	—	—	9.3	20	0	0	2.1	210	0	0	(244.0)	(12)	0	0
259	190.5	17	9.7	9	9.7	12	0	0	1.2	24	(84)	(1)	(127.5)	(100)	0	0
260	273.3	1193	—	—	2.1	10	334	100	.5	3	(209)	(3)	(400.0)	(100)	0	0
261	648.0	89	14.7	117	131.1	476	0	0	2.5	10	0	0	(794.0)	(58)	—	—
262	159.5	42	2.9	11	122.2	698	—	—	.5	50	(194)	(9)	(90.0)	(100)	0	0
263	79.2	5	8.8	880	1.4	1	0	0	.3	0	—	—	(87.0)	(5)	0	0
264	36.0	14	4.0	26	56.7	98	130	32	.4	13	—	—	(225.5)	(46)	0	0
265	90.0	35	10.0	66	31.6	126	155	9	.4	40	—	—	(286.0)	(22)	0	0
266	100.0	19	100.0	266	71.1	27	—	—	3.5	10	—	—	(264.0)	(72)	0	0
267	393.3	83	69.7	146	818.0	556	—	—	3.8	3	—	—	(546.0)	(23)	0	0
268	285.6	72	129.0	368	71.2	114	—	—	3.7	370	—	—	(486.0)	(30)	—	—
269	42.8	6	11.2	14	32.8	13	—	—	.6	8	—	—	(85.5)	(14)	0.0	0
270	26.0	7	6.9	17	36.7	39	—	—	.4	40	—	—	(68.5)	(27)	0.0	0
271	10.0	4	—	—	.6	1	—	—	.1	0	—	—	(9.0)	(90)	0.0	0
272	10.0	4	0.0	0	10.6	4	—	—	.1	10	—	—	(20.5)	(14)	0.0	0
273	9.0	2	1.0	6	.4	0	65	33	.1	0	—	—	(84.5)	(9)	0.0	0
274	0.0	0	0.0	0	50.0	200	—	—	0.0	0	—	—	(50.0)	(3)	0.0	0
275	5.0	31	—	—	0.0	0	—	—	0.0	0	—	—	(4.0)	0	0.0	0
301	166.6	34	56.5	282	45.8	33	69.9	13	0.0	0	—	—	(6.0)	(85)	—	—
302	(42.0)	(15)	77.2	359	0.0	0	0.0	0	0.0	0	—	—	(35.2)	(76)	0.0	0
303	(30.3)	(39)	27.4	2740	8.3	4	0.0	0	—	—	—	—	(5.5)	(64)	0.0	0
304	0.0	0	0.0	0	0.0	0	—	—	0.0	0	—	—	—	—	0.0	0
305	0.0	0	0.0	0	0.0	0	—	—	—	—	—	—	0.0	0	—	—
306	86.8	32	77.0	320	9.8	11	—	—	0.0	0	—	—	—	—	0.0	0
307	(177.2)	(39)	151.0	201	43.5	64	—	—	(30.8)	(77)	—	—	13.5	60	0.0	0
308	0.0	0	0.0	0	19.5	4	31.7	10	0.0	0	—	—	(100.2)	(83)	49.0	110
309	(234.1)	(34)	220.2	425	23.6	10	0.0	0	0.0	0	—	—	(9.6)	(23)	0.0	0
310	(85.8)	(32)	63.0	630	22.8	14	7.8	97	—	—	—	—	(7.8)	(78)	—	—
311	(152.1)	(39)	76.1	1087	(15.7)	(21)	66.6	52	0.0	0	—	—	—	—	25.1	2500
312	(59.3)	(17)	61.3	1021	0.0	0	.7	0	0.0	0	—	—	(2.6)	(65)	—	—
313	(108.2)	(17)	104.5	227	13.8	6	—	—	0.0	0	—	—	(10.1)	(36)	0.0	0
314	(119.6)	(22)	107.2	307	42.9	20	19.0	10	0.0	0	—	—	(49.4)	(76)	—	—
315	(53.5)	(11)	78.4	93	11.5	4	0.0	0	0.0	0	—	—	(36.4)	(66)	0.0	0
316	(70.9)	(58)	57.8	144	30.2	9	0.0	0	0.0	0	—	—	(17.2)	(70)	—	—
317	(62.4)	(8)	231.6	242	21.8	5	30.9	25	0.0	0	—	—	(221.9)	(76)	0.0	0
318	0.0	0	77.2	179	0.0	0	28.8	10	0.0	0	—	—	(106.0)	(78)	0.0	0

Tract	Single Family		Multi-Family		Commercial		Industrial		Open		Agriculture		Vacant		Other	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
319	21.8	5	4.3	10	0.0	0	40.7	136	0.0	0	—	—	(66.9)	(78)	0.0	0
320	0.0	0	34.2	22	56.0	27	56.1	97	0.0	0	—	—	(146.4)	(79)	0.0	0
321	(111.6)	(18)	59.3	110	60.3	43	79.4	9	0.0	0	—	—	(87.6)	(57)	0.0	0
322	169.7	19	34.5	431	136.3	130	114.1	9	0.0	0	—	—	(454.5)	(48)	0.0	0
323	314.3	62	73.3	114	78.3	68	61.6	44	0.0	0	—	—	(527.5)	(87)	0.0	0
324	0.0	0	136.6	89	47.5	3	136.3	197	0.0	0	—	—	(321.4)	(71)	0.0	0
325	58.9	9	51.6	374	42.7	10	88.4	256	0.0	0	—	—	(232.2)	(71)	0.0	0
326	0.0	0	40.2	359	14.5	18	(5.4)	(72)	0.0	0	—	—	(49.3)	(71)	0.0	0
327	134.2	19	—	—	53.7	32	—	—	—	—	—	—	(223.4)	(71)	35.5	355
328	165.3	17	7.9	20	0.0	0	0.0	0	21.1	92	—	—	(194.2)	(58)	—	—
329	(462.6)	(57)	203.6	370	69.1	64	612.0	621	223.3	538	—	—	(619.8)	(77)	0.0	0
330	25.7	8	27.8	63	44.9	374	232.6	83	0.0	0	—	—	(276.2)	(75)	0.0	0
331	37.7	107	260.0	500	221.4	37	467.8	542	0.0	0	—	—	(987.0)	(46)	0.0	0
332	549.5	95	101.0	404	212.5	284	80.8	84	46.4	244	—	—	(990.2)	(36)	—	—
333	159.8	53	165.2	1206	36.5	170	(17.2)	(8)	—	—	—	—	(34.4)	(67)	0.0	0
334	559.3	75	163.6	270	302.4	156	26.1	79	44.0	81	—	—	(1095.4)	(44)	0.0	0
335	260.9	23	104.9	411	90.4	70	60.3	99	0.0	0	—	—	(516.4)	(43)	—	—
336	430.5	181	211.0	191	46.6	416	27.5	132	—	—	—	—	(788.8)	(68)	78.0	7800
337	182.6	211	—	—	27.5	2750	112.6	490	16.5	650	—	—	(339.1)	(40)	0.0	0
338	318.4	71	115.2	253	128.6	352	280.7	322	33.7	3370	—	—	(876.6)	(38)	0.0	0
339	517.0	10	120.2	389	190.5	193	153.0	52	57.0	5700	—	—	(1038.5)	(50)	0.0	0
340	455.6	85	—	—	43.3	62	—	—	0.0	0	—	—	(499.0)	(36)	—	—
341	60.0	97	0.0	0	11.1	1110	0.0	0	2.6	260	—	—	(73.8)	(4)	—	—
342	646.4	401	—	—	86.1	207	—	—	—	—	—	—	(732.5)	(21)	—	—
343	287.2	41.0	63.8	41	134.9	76	0.0	0	0.0	0	—	—	(485.9)	(20)	—	—
344	487.7	214.0	0.0	0	28.2	25	554.4	362	26.8	2680	—	—	(1097.0)	(65)	—	—
345	684.5	156.0	144.4	186	123.9	42	47.8	25	39.4	171	—	—	(1011.5)	(32)	—	—
346	245.5	91.0	114.8	442	143.5	62	172.0	1720	30.0	265	—	—	(705.7)	(58)	0.0	0
347	26.5	2.0	23.7	31	169.0	94	115.7	88	14.0	29	—	—	(348.9)	(36)	0.0	0
348	19.0	2.0	27.1	47	8.9	2	0.0	0	2.0	17	—	—	(86.5)	(18)	—	—
349	6.9	1.0	20.8	59	3.3	1	—	—	.7	70	—	—	(30.8)	(45)	0.0	0
350	34.5	6.0	12.5	16	5.6	3	15.0	11	1.3	8	—	—	(71.5)	(41)	0.0	0
351	0.0	0.0	0.0	0	0.0	0	10.0	5	—	—	—	—	(8.0)	(80)	0.0	0
352	—	—	0.0	0	.5	2	345.0	33	—	—	—	—	(341.5)	(24)	0.0	0
353	(10.8)	(2.1)	(20.7)	(92)	(1.6)	(2)	0.0	0	0.0	0	—	—	22.5	13	0.0	0
354	—	—	—	—	—	—	650.0	146	—	—	—	—	(650.0)	(45)	0.0	0
355	(54.2)	(9.0)	(14.5)	(19)	(3.8)	(3)	—	—	0.0	0	—	—	59.5	7	0.0	0
356	76.1	13.0	76.1	51	49.1	14	—	—	5.4	22	—	—	203.5	(53)	0.0	0
357	0.0	0.0	0.0	0	25.0	8	—	—	0.0	0	—	—	25.0	(2)	0.0	0
358	143.8	23.0	143.6	144	25.2	17	—	—	5.7	570	—	—	316.0	(96)	0.0	0
359	375.5	59.0	219.5	209	113.0	74	11.3	(65)	(3.2)	(64)	—	—	743.6	(12)	21.1	6
360	365.7	35.0	121.9	104	76.7	19	190.0	1900	7.2	18	—	—	761.5	(16)	—	—
361	—	—	—	—	0.0	0	650.0	27	0.0	0	—	—	650.5	(39)	0.0	0
362	50.0	125.0	—	—	.3	30	750.0	98	.1	0	—	—	800.0	(16)	0.0	0
363	81.5	21.0	0.0	0	2.8	16	0.0	0	.6	60	0	0	83.5	(3)	—	—
364	9.8	8.0	—	—	.4	1	600.0	1000	.1	10	—	—	(609.5)	(31)	0.0	0
365	14.3	3.0	6.5	15	1.5	1	—	—	.3	1	—	—	(21.5)	(1)	—	—
366	134.7	15.0	61.7	123	213.9	10	1505.0	141	3.1	5	0	0	(1917.0)	(31)	0.0	0
367	19.5	11.0	—	—	.8	11	0.0	0	.2	4	0	0	(18.0)	(1)	0.0	0
368	100.0	15.0	0.0	0	4.3	1	0.0	0	1.0	3	0	0	(103.5)	(5)	0.0	0

Tract	Single Family		Multi-Family		Commercial		Industrial		Open		Agriculture		Vacant		Other	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
369	167.3	46	32.7	163	11.6	24	—	—	2.6	1	0	0	(212.0)	(12)	0.0	0
370	477.0	195	76.9	308	265.5	287	1757.8	88	41.4	22	0	0	(972.7)	(8)	0.0	0
371	776.8	58	302.2	544	491.8	285	33.2	34	213.4	119	0	0	(1817.5)	(24)	0.0	0
372	180.7	65	—	—	12.2	244	0.0	0	2.8	93	0	0	(293.5)	(95)	0.0	0
373	152.3	21	172.3	164	111.2	34	0.0	0	6.8	3	0	0	(460.6)	10	0.0	0
374	0.0	0	0.0	0	25.0	16	0.0	0	0.0	0	—	—	(25.0)	(1)	0.0	0
375	393.3	175	21.0	210	20.0	21	—	—	4.5	18	0	0	(437.0)	(92)	0.0	0
401	0.0	0	19.0	50	0.0	0	0.0	0	0.0	0	—	—	19.1	(66)	—	—
402	369.9	(85)	258.0	697	112.4	184	—	—	0.0	0	0	0	.5	(89)	0.0	0
403	(67.7)	(31)	73.9	126	0.0	0	—	—	—	—	—	—	6.2	(75)	0.0	0
404	119.0	27	99.1	308	30.0	31	0.0	0	0.0	0	—	—	10.2	(66)	0.0	0
405	81.6	(29)	103.1	116	10.2	4	—	—	—	—	—	—	31.7	(65)	0.0	0
406	88.9	(11)	69.3	235	21.6	30	—	—	0.0	0	—	—	2.0	(67)	—	—
407	103.5	(33)	136.2	85	.2	0	0.0	0	.1	2	—	—	31.8	(74)	0.0	0
408	15.4	(6)	—	—	1.0	(7)	—	—	—	—	—	—	14.0	108	—	—
409	5.0	1	—	—	.3	1	0.0	0	.1	10	—	—	(5.0)	(31)	—	—
410	1.4	(2)	0.0	0	(.1)	(1)	—	—	0.0	0	—	—	.5	(2)	—	—
411	0.0	0	0.0	0	(.9)	(4)	—	—	0.0	0	—	—	0.0	0	—	—
412	0.0	0	22.0	82	0.0	0	—	—	.1	4	—	—	(22.0)	(80)	—	—
413	17.4	2	68.2	58	12.3	11	—	—	0.0	0	—	—	97.9	(66)	0.0	0
414	10.7	(2)	131.7	106	56.2	47	—	—	0.0	0	—	—	183.4	(61)	0.0	0
415	0.0	0	124.5	180	84.6	94	51.8	50	.1	1	—	—	179.6	(43)	0.0	0
416	39.3	4	86.2	31	(17.7)	(4)	0.0	0	.1	1	—	—	29.3	(87)	0.0	0
417	84.6	(7)	7.5	(100)	(4.9)	(4)	—	—	0.0	0	—	—	94.0	940	0.0	0
418	8.1	(1)	3.7	(6)	1.0	(0)	—	—	0.0	0	—	—	10.0	10	0.0	0
419	218.8	(58)	438.1	78	134.1	18	0.0	0	19.4	1940	—	—	(214.4)	(84)	0.0	0
420	0.0	0	65.9	22	62.6	15	—	—	0.0	0	—	—	(128.5)	(76)	0.0	0
421	42.1	7	13.0	13	0.0	0	—	—	0.0	0	—	—	55.0	(27)	0.0	0
422	85.5	6	222.1	74	11.6	7	—	—	0.0	0	—	—	319.2	(65)	—	—
423	401.0	35	288.9	73	103.3	17	300.1	283	(37.1)	(84)	—	—	1083.5	(82)	27.1	36
424	77.8	11	279.7	145	88.4	14	310.9	141	.1	0	—	—	776.8	(85)	20.0	36
425	0.0	0	123.0	102	72.4	11	—	—	0.0	0	—	—	(195.3)	(87)	0.0	0
426	42.7	8	20.2	29	7.7	18	0.0	0	.1	0	—	—	(70.1)	(79)	0.0	0
427	8.1	2	24.0	12	26.1	32	—	—	—	—	—	—	(58.4)	(23)	—	—
428	177.9	24	—	—	184.1	667	—	—	(6.2)	(90)	—	—	—	—	—	—
429	39.8	8	—	—	15.9	35	—	—	0.0	0	—	—	—	—	13.7	1370
430	32.8	16	20.1	46	14.5	10	84.0	106	—	—	—	—	(234.3)	(61)	82.7	8270
431	(50.8)	(10)	17.7	177	33.1	51	—	—	0.0	0	—	—	—	—	—	—
432	205.2	136	139.4	231	46.2	275	9.4	10	31.6	3160	—	—	(431.8)	(81)	0.0	0
433	313.0	51	34.8	82	88.4	136	0.0	0	4.2	420	—	—	436.0	(19)	0.0	0
434	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	—	—	0.0	0	0.0	0
435	—	—	—	—	0.0	0	—	—	0.0	0	—	—	0.0	0	0.0	0
436	969.3	67	323.1	239	334.1	144	181.0	103	19.0	1900	—	—	1803.5	(46)	0.0	0
437	239.5	186	341.8	380	20.8	104	0.0	0	4.7	470	(183.0)	(2)	(160.0)	(100)	0.0	0
438	1263.4	85	942.5	534	503.8	111	0.0	0	40.4	16	(2294.0)	(21)	(455.0)	(100)	0.0	0
439	(104.7)	(11)	37.2	18	71.6	77	—	—	0.0	0	—	—	(41.5)	(19)	37.4	3740
440	157.5	5	17.5	25	57.8	15	—	—	.6	3	—	—	(233.0)	(56)	0.0	0
441	29.5	5	88.2	8820	78.2	67	(14.1)	(74)	—	—	—	—	(181.8)	(74)	0.0	0

Tract	Single Family Acres	Single Family %	Multi-Family Acres	Multi-Family %	Commercial Acres	Commercial %	Industrial Acres	Industrial %	Open Acres	Open %	Agriculture Acres	Agriculture %	Vacant Acres	Vacant %	Other Acres	Other %
442	(72.3)	(7)	106.6	93	24.9	12	178.6	25	0.0	0	—	—	(237.7)	(79)	0.0	0
443	294.4	16	12.9	4	0.0	0	94.4	45	0.0	0	—	—	(401.7)	(85)	—	—
444	204.2	13	157.6	52	41.7	11	59.5	46	—	—	—	—	(477.5)	(83)	0.0	0
445	121.5	10	109.4	89	0.0	0	—	—	0.0	0	—	—	148.2	(67)	0.0	0
446	83.6	4	185.0	66	0.0	0	—	—	0.0	0	—	—	268.5	(70)	0.0	0
447	404.7	34	445.2	244	154.6	73	84.6	12	0.0	0	—	—	1207.4	(55)	118.3	65
448	50.0	71	—	—	0.0	0	—	—	.1	0	50.0	(1)	—	—	0.0	0
449	298.3	98	15.9	91	207.1	193	—	—	3.4	340	0.0	0	521.0	(3)	0.0	0
450	195.3	107	47.5	1900	168.2	561	375.0	625	1.9	1	—	—	916.8	(13)	0.0	0
451	145.9	82	16.2	1620	123.6	123	—	—	1.9	190	0.0	0	285.0	(34)	0.0	0
452	300.2	39	54.7	2370	156.6	261	275.0	275	1.5	2	787.0	4	—	—	0.0	0
501	—	—	6.5	650	.6	2	0.0	0	—	—	—	—	(7.0)	(64)	0.0	0
502	(47.9)	(43)	36.3	454	38.1	115	0.0	0	0.0	0	—	—	(26.5)	(77)	0.0	0
503	(258.9)	(50)	58.9	171	49.3	40	161.0	1610	0.0	0	—	—	(23.8)	(79)	0.0	0
504	(31.4)	(21)	32.9	477	0.0	0	0.0	0	.1	0	—	—	(3.6)	(63)	0.0	0
505	265.3	532	30.8	446	0.0	0	4.4	2	0.0	0	—	—	(14.6)	(63)	0.0	0
506	(81.5)	(16)	83.5	474	5.8	14	—	—	0.0	0	—	—	(7.8)	(77)	—	—
507	(75.6)	(15)	54.3	218	27.5	32	0.0	0	0.0	0	—	—	(6.2)	(65)	0.0	0
508	(98.2)	(34)	101.1	733	5.7	9	0.0	0	—	—	—	—	(8.6)	(78)	—	—
509	(111.8)	(12)	81.8	1320	27.5	35	48.4	136	0.0	0	—	—	(45.9)	(118)	0.0	0
510	(12.1)	(3)	0.0	0	11.9	31	18.7	82	0.0	0	—	—	(18.5)	(81)	0.0	0
511	(91.2)	(18)	31.0	287	63.0	70	—	—	0.0	0	—	—	(2.8)	(8)	0.0	0
512	(31.9)	(6)	36.3	390	0.0	0	—	—	0.0	0	—	—	(4.4)	(69)	—	—
513	(81.7)	(32)	64.7	1294	17.1	19	—	—	0.0	0	—	—	—	—	0.0	0
514	(53.6)	(15)	64.8	261	4.7	9	5.2	5	0.0	0	—	—	(21.1)	(64)	0.0	0
515	(29.2)	(5)	37.9	73	0.0	0	—	—	0.0	0	—	—	(8.6)	(66)	0.0	0
516	(107.4)	(20)	92.7	1306	9.3	7	43.3	15	0.0	0	—	—	(37.9)	(61)	0.0	0
517	(129.0)	(14)	189.7	92	80.3	21	149.1	30	28.3	165	—	—	(576.8)	(63)	0.0	0
518	(36.7)	(3)	54.7	115	78.0	22	0.0	0	12.5	133	—	—	(108.4)	(60)	0.0	0
519	57.6	5	0.0	0	0.0	0	0.0	0	0.0	0	—	—	(57.6)	(88)	—	—
520	35.3	5	0.0	0	72.6	31	0.0	0	0.0	0	—	—	(107.9)	(36)	0.0	0
521	(9.8)	(1)	90.8	330	23.9	13	.1	0	—	—	—	—	(104.9)	(76)	—	—
522	0.0	0	16.9	89	29.7	22	5.3	63	30.1	239	—	—	(82.1)	(37)	—	—
523	(33.8)	(3)	14.3	12	55.3	21	0.0	0	0.0	0	—	—	(35.8)	(42)	0.0	0
524	0.0	0	15.2	1520	0.0	0	—	—	—	—	—	—	(15.2)	(79)	—	—
525	808.2	78	341.3	1648	0.0	0	0.0	0	0.0	0	—	—	(149.4)	(63)	—	—
526	19.3	1	24.6	91	44.5	23	0.0	0	0.0	0	—	—	(88.4)	(48)	—	—
527	40.0	7	0.0	0	0.0	0	0.0	0	0.0	0	—	—	(40.0)	(6)	0.0	0
528	287.2	64	148.2	1482	25.0	75	68.7	23	—	—	—	—	(529.2)	(63)	—	—
529	942.3	203	564.6	329	299.6	171	0.0	0	0.0	0	—	—	(1806.5)	(60)	0.0	0
530	718.6	30	194.1	990	56.1	23	0.0	0	0.0	0	—	—	(968.9)	(48)	—	—
531	634.0	35	70.4	63	37.2	14	—	—	8.4	29	—	—	(748.8)	(38)	0.0	0
532	69.2	4	0.0	0	20.9	9	0.0	0	0.0	0	—	—	(90.0)	(15)	0.0	0
533	322.8	12	321.8	214	76.4	54	300.0	4000	12.7	50	—	—	(1131.0)	(56)	0.0	0
534	382.1	123	42.5	104	152.4	320	0.0	0	5.1	12	—	—	(579.0)	(23)	0.0	0
535	111.0	140	12.3	1230	226.5	221	375.0	576	1.5	150	(415.0)	(8)	(310.0)	(100)	0.0	0
536	713.5	77	99.3	993	241.9	111	—	—	9.5	190	0.0	0	(1042.5)	(39)	0.0	0
537	409.2	64	0.0	0	192.8	188	0.0	0	4.0	400	0.0	0	(603.5)	(11)	0.0	0

	Single Family		Multi-Family		Commercial		Industrial		Open		Agriculture		Vacant		Other	
Tract	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
538	966.2	59	107.4	613	286.7	144	—	—	12.8	4	0.0	0	(1371.5)	(39)	0.0	0
539	350.5	29	38.9	59	125.6	86	0.0	0	4.6	46	0.0	0	(517.5)	(18)	0.0	0
540	946.0	106	87.8	878	192.5	1100	245.0	98	11.9	95	—	—	(1477.5)	(51)	0.0	0
541	428.7	48	22.9	45	321.8	201	350.0	200	4.9	2	(236.0)	(2)	(890.0)	(100)	0.0	0
542	507.4	90	0.0	0	127.7	88	305.0	149	4.0	0	0.0	0	(842.5)	(60)	0.0	0
543	16.7	9	5.6	56	1.5	5	0.0	0	.3	10	(22.0)	(0)	—	—	0.0	0
544	11.0	84	—	—	.3	30	130.0	40	.1	10	(140.0)	(1)	—	—	0.0	0
545	642.9	29	41.4	92	167.8	93	0.0	0	8.5	10	0.0	0	(888.0)	(17)	0.0	0
546	153.0	76	—	—	1.7	1	0.0	0	.4	40	0.0	0	(153.0)	(34)	0.0	0
547	88.7	22	—	—	1.0	1	0.0	0	.2	20	(119.0)	(0)	—	—	0.0	0
548	24.8	5	0.0	0	.7	1	—	—	.2	0	0.0	0	(24.0)	(3)	0.0	0
549	173.2	27	—	—	1.7	1	—	—	.4	40	0.0	0	(153.0)	(5)	0.0	0
550	228.6	25	0.0	0	2.4	4	—	—	.5	50	0.0	0	(219.0)	(12)	0.0	0
551	531.1	67	28.7	95	27.0	29	0.0	0	6.1	610	0.0	0	(610.0)	(7)	0.0	0
552	107.7	17	5.7	81	45.5	36	0.0	0	1.2	1	0.0	0	(159.0)	(7)	0.0	0
553	49.0	11	6.6	66	78.5	62	0.0	0	.8	5	—	—	(143.0)	(2)	0.0	0
554	42.1	18	—	—	1.1	13	0.0	0	.4	0	0.0	0	(42.5)	(2)	0.0	0
555	306.3	53	40.4	323	701.4	1336	0.0	0	4.4	7	0.0	0	(608.0)	(11)	0.0	0
556	263.9	37	29.3	2930	155.5	239	—	—	3.5	350	0.0	0	(449.0)	(12)	0.0	0
557	33.7	14	1.8	180	1.7	3	—	—	.4	40	0.0	0	(36.0)	(0)	0.0	0
558	617.2	68	68.6	228	231.2	318	0.0	0	8.2	54	—	—	(923.5)	(8)	0.0	0
559	698.5	84	77.6	310	231.0	298	0.0	0	9.3	930	0.0	0	(1015.0)	(8)	0.0	0

	Single Family		Multi-Family		Commercial		Industrial		Open		Undeveloped		Other	
Tract	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
601	385.3	39	31.5	92	21.1	7.0	60.0	93	4.8	229.0	(5027.0)	(7)	—	—
602	1121.2	73	124.2	264	65.7	42.0	35.0	119	14.8	122.0	(1356.7)	(39)	0.0	0
603	169.3	41	45.9	108	13.4	10.0	40.0	38	3.0	5.0	(270.6)	(7)	0.0	0
701	1252.7	54	200.6	172	81.3	31.0	645.0	3772	18.4	49.0	(2196.0)	(5)	0.0	0
703	220.0	44	11.8	251	11.2	5.0	232.0	45	2.6	20.0	(476.1)	(7)	0.0	0
704	60.3	40	—	—	.3	13.0	95.0	642	.1	10.0	(53.7)	(1)	0.0	0
705	21.5	19	0.0	0	.7	.5	175.0	1966	.2	20.0	(195.1)	(.9)	0.0	0
706	128.8	28	—	—	1.0	2.0	0.0	0	.2	0.0	(129.4)	(.2)	0.0	0
801	33.0	34	3.0	300	1.7	9.0	50.0	13	.4	6.0	(86.1)	(1)	0.0	0
802	262.8	51	0.0	0	7.1	4.0	40.0	138	1.6	160.0	(309.5)	(.3)	0.0	0
803	143.6	14	0.0	0	3.9	1.0	26.0	239	1.1	.3	(173.1)	(.1)	—	—
901	1058.5	41	53.4	485	53.3	43.0	200.0	952	12.0	4.0	(1377.9)	(3)	0.0	0
902	1605.3	94	259.8	835	104.6	59.0	380.0	1267	23.6	7.0	(2371.5)	(3)	0.0	0
903	803.5	37	0.0	0	34.9	23.0	0.0	0	7.9	8.0	(845.8)	(1)	0.0	0
904	127.8	29	—	—	.8	.1	0.0	0	.2	1.0	(29.0)	(0)	0.0	0
905	58.4	8	0.0	0	3.5	12.0	0.0	0	.8	.2	(130.3)	(.1)	0.0	0
1201	58.4	21	4.7	21	3.2	13.0	10.0	250	.7	1.0	(75.8)	(2)	0.0	0
1202	61.2	10	4.9	57	3.3	3.0	30.0	909	.8	2.0	(99.9)	(1.4)	0.0	0
1203	77.1	30	8.6	78	4.5	7.0	35.0	350	1.0	100.0	(124.5)	(.7)	0.0	0
1204	32.3	9	8.9	51	2.3	1.6	15.0	192	.5	.6	(55.9)	(2)	0.0	0
1205	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	(.1)	(0)	0.0	0
1206	1.6	0	.2	2	.1	.0	0.0	0	0.0	0.0	(.6)	(0)	0.0	0
1207	11.4	9	.6	3	.6	2.0	35.0	130	.1	10.0	(47.9)	(1)	—	—
1208	45.2	32	3.6	10	2.5	4.0	65.0	3421	.6	60.0	(114.6)	(1.6)	0.0	0
1209	6.2	2	0.0	0	.3	.4	0.0	0	.1	2.0	(5.2)	(.5)	0.0	0
1210	3.7	1	0.0	0	.2	.6	40.0	20	0.0	0.0	(42.6)	(1.3)	—	—
1211	.4	0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	(0.2)	(0)	—	—
1212	160.8	31	17.9	44	9.4	7.0	0.0	0	2.1	162.0	(188.5)	(40)	0.0	0
1213	70.1	17	3.6	20	3.5	5.0	20.0	92	.7	1.0	(96.6)	(3)	0.0	0
1214	31.7	8	0.0	0	1.2	2.0	0.0	0	.3	.6	(31.3)	(.1)	0.0	0
1215	11.0	5	1.2	26	.6	.6	50.0	714	.1	.2	(60.6)	(1)	0.0	0
1216	35.3	9	2.8	50	1.9	3.0	175.0	13	.4	.1	(213.6)	(1)	0.0	0

EMPLOYMENT

GREATER HOUSTON 208 PROGRAM
EMPLOYMENT ESTIMATES
AND PROJECTIONS

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
121	307	0	2	0	0	0	0
122	147	3	1	0	0	0	3
123	156	3	8	0	0	0	3
124	323	6	4	0	1	0	7
125	0	0	0	0	0	0	0
126	674	41	327	14	47	1	64
201	70	0	0	0	0	0	0
202	205	1	4	0	0	0	1
203	234	9	19	0	2	0	9
204	121	19	4	0	1	0	20
205	153	9	13	0	1	0	9
206	42	4	2	0	0	0	4
207	473	10	47	0	5	0	12
208	323	8	24	0	2	0	8
209	319	9	5	0	1	0	9
210	2,660	21	244	1	68	0	23
211	290	7	37	0	0	0	7
212	0	0	0	0	0	0	0
213	237	34	82	8	17	1	48
214	351	20	54	2	11	0	23
215	255	22	51	3	10	0	28
216	19	7	0	0	0	0	7
217	46	13	3	0	1	0	14
218	528	27	175	7	21	0	37
219	386	25	42	2	13	0	28
220	163	19	28	2	5	0	23
221	0	0	0	0	0	0	0
222	9	1	0	0	0	0	1
223	74	15	13	2	1	0	18
224	156	17	25	2	4	0	20
225	107	12	14	1	1	0	14
226	183	61	81	16	37	6	90
227	272	65	77	11	49	6	96
228	201	35	63	8	17	2	50
229	447	66	247	18	95	6	117
230	121	15	24	2	2	0	19
231	42	4	1	0	0	0	4
232	534	7	32	0	2	0	7
233	510	28	149	6	28	1	38
234	6	1	0	0	0	0	1
235	250	20	58	3	7	0	25
236	717	149	645	53	437	23	375
237	2	1	0	0	0	0	1
238	138	260	177	92	129	35	837
239	45	21	11	4	2	0	27
240	64	6	5	0	0	0	7
241	190	68	110	23	42	7	123
242	6	0	0	0	0	0	0
243	221	8	15	0	1	0	8
244	12	10	2	1	0	0	12
245	180	18	29	2	5	1	20
246	25	100	20	41	9	13	225
247	5	2	1	1	0	0	2
248	1	2	0	0	0	0	2
249	77	18	15	3	2	1	22
250	25	11	3	1	0	0	12
251	1	6	0	0	0	0	5
252	1	6	0	0	0	0	6

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
253	9	5	1	1	0	0	6
254	53	11	6	1	1	1	12
255	1	1	0	0	0	0	0
256	0	0	0	0	0	0	0
257	7	3	0	0	0	0	3
258	16	7	1	1	0	0	7
259	27	5	2	1	0	0	5
260	19	38	8	12	1	1	56
261	499	73	269	23	125	1	130
262	842	100	777	56	538	10	400
263	2	1	0	0	0	0	0
264	111	23	33	6	3	1	30
265	90	6	7	1	7	1	5
266	255	12	27	1	3	1	13
267	(856)	(86)	325	244	9,881	95	935
268	87	37	27	8	8	1	51
269	9	3	1	1	0	0	3
270	29	6	3	1	0	0	6
271	12	3	2	1	0	0	3
272	0	0	0	0	0	0	0
273	48	20	10	3	1	1	24
274	666	45	243	11	81	1	66
275	0	0	0	0	0	0	0
301	1,138	10	143	1	7	5	11
302	0	0	0	0	0	0	0
303	81	1	0	0	0	0	1
304	0	0	0	0	0	0	0
305	0	0	0	0	0	0	0
306	136	8	5	1	0	0	8
307	1,761	35	503	7	141	1	47
308	221	4	8	1	0	0	3
309	535	3	14	1	1	0	3
310	349	11	34	1	3	0	11
311	837	15	111	1	6	0	17
312	3	0	0	0	0	0	0
313	120	4	5	0	0	0	3
314	300	9	26	0	2	0	10
315	91	2	1	0	0	0	2
316	921	6	46	0	3	0	5
317	415	6	23	0	1	0	6
318	160	3	4	0	1	0	3
319	677	13	80	1	10	0	15
320	1,577	24	326	4	67	0	29
321	449	0	6	0	1	0	8
322	556	11	53	0	5	0	11
323	297	29	105	8	13	0	41
324	415	7	38	0	1	0	7
325	901	17	70	1	16	0	18
326	82	6	2	0	0	0	6
327	125	19	10	1	3	0	12
328	0	0	0	0	0	0	0
329	1,037	116	770	40	479	17	255
330	1,692	48	625	12	233	4	72
331	1,894	50	609	11	270	4	73
332	543	79	288	23	154	10	143
333	31	5	1	0	0	0	4
334	578	70	267	19	137	8	118
335	384	41	175	13	30	2	62
336	336	129	270	42	194	21	292
337	150	190	138	61	124	34	546
338	1,123	128	830	42	596	21	291
339	1,352	46	245	7	127	3	58
340	114	33	44	10	7	1	47

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
341	14	30	4	7	1	1	40
342	264	86	71	12	59	9	128
343	232	39	73	9	22	2	55
344	1,065	65	305	11	193	6	94
345	374	17	52	2	8	0	19
346	2,369	67	1,074	18	530	7	112
347	1,238	43	603	15	98	2	66
348	14	0	0	0	0	0	0
349	72	0	1	0	0	0	0
350	0	0	0	0	0	0	0
351	19	2	1	0	0	0	2
352	73	16	10	0	2	0	18
353	(13)	(1)	0	0	0	0	(1)
354	572	57	321	20	85	4	97
355	(19)	(1)	1	0	0	0	(1)
356	487	6	47	0	1	0	6
357	28	2	1	0	0	0	1
358	43	7	4	0	0	0	7
359	846	29	206	5	49	1	37
360	473	14	725	19	807	26	16
361	397	9	34	0	3	0	10
362	388	23	77	4	15	0	28
363	7	1	0	0	0	0	1
364	90	80	51	25	25	10	146
365	0	0	0	0	0	0	0
366	1,187	45	433	11	143	3	66
367	1	0	0	0	0	0	0
368	5	0	0	0	0	0	0
369	60	12	8	1	0	0	13
370	659	37	200	8	58	2	51
371	793	87	456	27	255	12	164
372	198	54	103	18	29	4	90
373	1,097	16	193	2	20	0	18
374	0	0	0	0	0	0	0
375	40	9	4	0	0	0	10
401	0	0	0	0	0	0	0
402	3,755	87	1,266	16	999	11	140
403	0	0	0	0	0	0	0
404	742	17	49	0	12	0	8
405	211	2	2	0	0	0	2
406	429	17	32	1	7	0	18
407	4	0	0	0	0	0	0
408	(43)	(3)	2	0	0	0	(3)
409	0	0	0	0	0	0	0
410	(37)	0	0	0	0	0	0
411	(7)	0	0	0	0	0	0
412	0	0	0	0	0	0	0
413	57	6	1	0	0	0	6
414	650	26	72	2	23	0	30
415	344	10	31	0	3	0	10
416	(166)	(2)	5	0	0	0	(2)
417	(26)	(1)	0	0	0	0	(1)
418	(8)	0	0	0	0	0	0
419	76,808	356	107,251	109	98,486	48	1,294
420	1,281	9	102	0	9	0	9
421	0	0	0	0	0	0	0
422	136	4	5	0	1	0	4
423	5,652	30	1,881	8	302	1	41
424	2,651	27	851	7	106	0	36
425	662	7	63	0	63	0	7
426	188	9	15	0	2	0	9
427	60	19	10	3	2	0	22
428	1,328	109	1,272	50	356	9	243
429	63	19	15	4	1	0	23
430	363	25	78	4	16	0	31
431	301	26	98	7	11	0	35
432	199	30	78	9	7	0	42
433	242	26	59	5	12	0	34
434	2,104	82	1,469	31	539	9	159
435	740	110	689	49	225	11	113

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	EMPLOYEE INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
436	467	49	243	26	51	3	80
437	111	23	28	5	4	0	30
438	580	28	138	5	33	1	36
439	476	38	198	12	38	2	57
440	173	6	10	0	1	0	6
441	132	26	28	4	7	1	33
442	2,031	13	239	1	29	0	14
443	516	8	51	0	3	0	91
444	850	12	121	2	8	0	13
445	0	0	0	0	0	0	0
446	0	0	0	0	0	0	0
447	909	15	111	2	17	0	16
448	0	0	0	0	0	0	0
449	69	84	42	28	21	11	16
450	136	160	128	58	88	25	414
451	18	100	13	36	6	12	205
452	332	88	186	26	109	12	165
501	9	0	0	0	0	0	0
502	344	8	24	0	2	0	8
503	2,978	47	1,583	22	719	8	126
504	0	0	0	0	0	0	0
505	36	0	0	0	0	0	0
506	83	9	6	0	1	0	9
507	172	12	5	0	0	0	12
508	38	4	1	0	0	0	4
509	648	35	190	8	54	2	48
510	359	27	86	5	19	1	67
511	1,454	37	444	8	127	2	51
512	0	0	0	0	0	0	0
513	167	11	3	0	1	0	10
514	55	2	1	0	0	0	3
515	0	0	0	0	0	0	0
516	650	7	8	0	1	0	7
517	1,763	14	103	0	20	0	15
518	494	12	25	0	4	0	125
519	0	0	0	0	0	0	0
520	313	15	45	2	5	0	17
521	103	5	4	0	0	0	4
522	11	0	24	1	3	0	16
523	302	11	31	1	3	0	12
524	0	0	0	0	0	0	0
525	0	0	0	0	0	0	0
526	403	12	45	1	5	0	13
527	0	0	0	0	0	0	0
528	453	16	51	1	9	0	17
529	1,430	61	769	20	259	6	105
530	88	12	9	1	1	0	13
531	39	6	3	0	0	0	6
532	106	5	7	0	0	0	5
533	719	36	242	9	60	2	51
534	832	66	517	25	152	6	119
535	626	68	323	21	143	8	119
536	328	50	135	14	47	4	77
537	339	44	129	12	38	3	65
538	502	51	224	15	72	4	80
539	163	30	46	6	10	1	39
540	780	58	338	16	142	6	94
541	1,060	74	460	18	270	9	166
542	1,565	50	1,565	33	229	4	67
543	8	1	8	1	0	0	1
544	2	15	1	7	0	0	23
545	86	20	16	3	3	0	24
546	0	0	0	0	0	0	0
547	1	0	0	0	0	0	0
548	0	0	0	0	0	0	0

TRACT	1975-1983 EMPLOYEE INCREASE	1975-1983 PERCENTAGE INCREASE	1983-1990 EMPLOYEE INCREASE	1983-1990 PERCENTAGE INCREASE	1990-1995 EMPLOYEE INCREASE	1990-1995 PERCENTAGE INCREASE	1975-1995 TOTAL PERCENTAGE INCREASE
549	0	0	0	0	0	0	0
550	1	3	0	0	0	0	2
551	54	11	7	1	0	0	12
552	13	10	3	2	0	0	12
553	155	21	37	4	5	0	26
554	1	6	0	0	0	0	5
555	98	21	22	4	3	0	26
556	237	62	140	23	39	5	108
557	0	0	0	0	0	0	0
558	517	60	249	18	97	6	79
559	192	85	136	32	52	9	167
601	134	18	12	1	1	0	19
602	75	13	9	1	2	0	15
603	19	15	3	2	1	0	18
701	1,973	53	787	14	312	5	82
703	252	21	46	3	9	0	25
704	951	320	1,209	97	1,206	49	133
705	68	66	35	20	15	7	114
706	3	1	0	0	0	0	1
801	17	9	2	0	0	0	10
802	46	17	6	2	0	0	19
803	11	4	0	0	0	0	3
901	166	36	49	8	14	2	49
902	233	65	117	20	49	7	111
903	112	9	9	0	1	0	9
904	1	4	0	0	0	0	4
905	12	6	0	0	0	0	6
1201	139	24	8	1	3	0	25
1202	65	12	1	0	1	0	12
1203	20	33	5	6	1	1	42
1204	11	5	0	0	0	0	4
1205	(118)	(9)	0	0	0	0	(94)
1206	1	0	0	0	0	0	0
1207	158	29	28	4	8	1	35
1208	298	55	82	10	45	5	79
1209	0	0	0	0	0	0	0
1210	2	12	0	0	0	0	11
1211	0	0	0	0	0	0	0
1212	11	3	1	0	0	0	3
1213	10	13	1	1	0	0	14
1214	0	0	0	0	0	0	0
1215	3	5	2	3	0	0	8
1216	38	6	1	0	0	0	6

POPULATION

GREATER HOUSTON 208 PROGRAM
TRANSPORTATION POPULATION
ESTIMATES AND PROJECTIONS

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	POPULATION INCREASE	PERCENTAGE INCREASE	POPULATION INCREASE	PERCENTAGE INCREASE	POPULATION INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
121	193	5	1,593	39	2,056	36	99
122	26	0	161	3	159	30	7
123	300	16	124	8	52	4	31
124	121	2	748	15	821	14	34
125	59	4	391	79	470	25	64
126	1,098	17	449	8	187	4	20
201	285	3	1,830	16	2,028	40	37
202	769	11	734	9	570	0	29
203	1,588	11	1,517	9	1,177	7	29
204	110	3	703	16	780	15	37
205	800	5	700	4	500	3	11
206	1,100	12	1,400	13	1,000	8	37
207	1,540	14	1,260	10	900	7	33
208	3,360	21	2,863	18	2,324	11	52
209	42	5	286	30	354	29	75
210	1,070	8	2,553	19	2,649	16	49
211	233	2	94	0	69	0	4
212	31	0	13	0	10	0	0
213	9,588	90	7,705	38	5,650	20	214
214	3,434	69	4,615	55	4,935	40	262
215	1,747	10	1,651	8	1,270	6	26
216	480	7	1,118	15	1,124	13	38
217	326	3	720	6	670	5	14
218	3,614	28	1,922	12	981	5	50
219	342	6	342	5	771	11	23
220	1,320	16	1,315	14	1,060	10	45
221	8	0	7	0	5	0	1
222	1,040	14	156	9	0	0	16
223	128	0	36	0	27	0	15
224	4,365	24	1,757	8	1,298	5	40
225	676	4	605	4	414	2	10
226	2,475	35	2,765	29	2,490	20	109
227	784	13	1,741	25	1,865	21	71
228	1,861	38	753	11	556	7	64
229	769	30	309	9	228	6	51
230	6,833	27	2,749	9	2,031	6	46
231	137	2	121	2	88	1	5
232	3,023	42	3,541	35	3,326	24	138
233	447	22	181	7	72	27	34
234	652	21	265	7	196	5	35
235	1,326	26	536	8	395	6	44
236	264	7	919	16	678	10	51
237	455	44	184	12	136	8	75
238	1,905	45	769	12	568	8	76
239	810	13	323	5	238	3	21
240	8,252	52	3,336	14	2,466	9	89
241	1,985	36	804	11	595	7	61
242	308	27	42	3	0	0	30
243	131	6	0	0	0	0	6
244	1,979	55	799	14	590	9	93
245	3,057	43	1,237	12	914	8	73
246	245	15	99	5	74	4	25
247	1,336	87	539	19	399	12	148
248	321	45	130	13	96	8	77
249	7,558	99	3,099	20	2,294	12	169
250	227	34	91	10	67	7	57
251	1,026	36	412	11	305	7	60
252	223	31	92	10	68	7	53

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	POPULATION INCREASE	PERCENTAGE INCREASE	POPULATION INCREASE	PERCENTAGE INCREASE	POPULATION INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
253	1,386	62	561	15	416	10	105
254	624	46	252	13	186	8	77
255	434	21	175	7	129	5	35
256	171	29	69	9	51	6	49
257	357	40	144	12	107	8	68
258	1,759	28	709	9	525	6	48
259	1,828	23	742	8	549	5	39
260	388	79	158	18	116	11	135
261	1,232	43	499	12	368	8	73
262	275	25	112	8	82	6	42
263	169	4	71	2	52	1	6
264	229	7	229	6	70	2	15
265	510	21	0	0	0	0	20
266	607	11	243	4	181	3	18
267	1,334	22	535	7	395	5	36
268	1,749	53	708	14	523	10	90
269	0	0	0	0	0	0	0
270	179	4	74	2	56	1	7
271	132	4	52	2	39	1	7
272	170	4	0	0	0	0	3
273	170	4	0	0	0	0	4
274	114	9	49	4	35	3	7
275	9	9	0	0	0	0	9
301	784	7	453	3	243	2	13
302	919	15	901	12	716	9	40
303	84	2	535	14	583	14	33
304	0	0	0	0	0	0	0
305	0	0	0	0	0	0	0
306	115	1	1,257	15	1,300	14	34
307	1,716	13	1,658	10	1,303	8	34
308	46	0	25	0	17	0	1
309	4,467	34	4,910	28	4,414	20	107
310	481	7	447	6	337	4	19
311	399	4	362	3	362	3	11
312	114	1	700	8	700	8	18
313	951	9	895	7	686	6	24
314	1,044	12	1,010	10	794	8	34
315	800	10	1,940	21	2,064	19	59
316	758	12	730	10	575	8	34
317	2,431	14	2,380	12	1,893	9	39
318	1,685	8	1,577	7	1,202	5	22
319	562	9	528	7	405	6	21
320	1,189	6	1,096	5	825	4	16
321	171	1	1,052	8	1,094	8	19
322	895	7	830	6	628	4	19
323	1,967	20	1,011	8	503	4	36
324	1,911	14	1,094	7	620	4	26
325	303	3	681	7	640	6	17
326	152	2	331	4	303	4	10
327	327	0	726	6	680	6	16
328	303	1	661	3	605	3	9
329	1,260	11	1,205	9	936	7	30
330	1,332	21	1,371	18	1,144	1[illegible]	62
331	1,989	120	3,277	89	4,226	61	572
332	3,251	40	3,765	33	3,508	23	131
333	2,238	60	2,887	48	2,974	34	220
334	4,594	61	5,946	49	6,144	34	223
335	4,383	29	2,344	12	1,201	5	52
336	2,790	55	3,500	44	3,520	31	194
337	490	80	700	63	775	43	322
338	1,920	55	2,412	44	2,421	31	195
339	1,324	12	3,381	27	3,770	24	78
340	2,348	27	1,244	11	634	5	48
341	132	32	146	26	130	19	99
342	533	40	1,862	100	3,175	85	418
343	1,970	15	1,950	14	1,570	9	44

TRACT	1975-1983 POPULATION INCREASE	1975-1983 PERCENTAGE INCREASE	1983-1990 POPULATION INCREASE	1983-1990 PERCENTAGE INCREASE	1990-1995 POPULATION INCREASE	1990-1995 PERCENTAGE INCREASE	1975-1995 TOTAL PERCENTAGE INCREASE
344	1,778	76	1,795	44	2,146	36	246
345	2,990	37	3,395	31	3,105	21	118
346	2,152	52	2,668	43	2,635	29	181
347	1,020	5	483	2	225	1	9
348	1,701	12	681	5	503	3	22
349	620	6	249	2	184	1	10
350	1,807	14	0	0	0	0	42
351	(2)	(0)	0	0	0	0	(0)
352	(89)	(40)	(37)	(28)	(28)	(29)	(70)
353	(646)	(6)	(266)	(3)	(197)	(1)	(10)
354	0	0	0	0	0	0	0
355	(698)	(5)	(298)	(2)	(222)	(1)	(8)
356	4,568	26	1,847	8	1,364	5	45
357	0	0	0	0	0	0	0
358	4,769	56	1,931	15	1,426	9	96
359	5,342	57	4,543	31	4,724	24	155
360	6,019	32	2,428	10	1,794	6	56
361	0	0	0	0	0	0	0
362	81	38	6	2	0	0	41
363	531	36	215	11	158	7	62
364	81	9	32	3	24	2	16
365	282	4	111	2	82	1	8
366	2,644	28	1,061	9	784	6	48
367	161	23	65	8	48	5	39
368	872	11	344	4	184	2	19
369	2,590	57	1,047	15	108	1	82
370	4,219	146	3,708	52	6,527	60	503
371	4,068	35	4,572	29	4,141	20	111
372	2,304	91	935	19	691	11	155
373	5,742	35	2,298	10	1,696	6	59
374	0	0	0	0	0	0	0
375	3,774	118	1,533	22	1,133	13	18
401	672	10	1,648	23	1,775	20	64
402	1,303	10	3,129	23	3,500	20	64
403	1,694	21	1,738	19	1,446	12	61
404	706	9	1,815	23	1,910	19	61
405	1,204	12	3,004	27	3,317	23	75
406	632	10	1,485	16	1,583	18	58
407	3,025	25	3,190	21	2,724	15	75
408	(188)	(5)	(76)	(2)	(56)	(1)	(10)
409	104	2	0	0	0	0	2
410	82	1	(7)	(0)	(4)	(0)	1
411	(20)	(1)	(8)	(0)	(6)	(0)	(2)
412	146	1	129	1	93	0	3
413	1,878	23	1,123	21	2,246	18	76
414	907	9	2,196	21	2,322	18	57
415	1,080	6	1,000	6	760	4	18
416	5,037	23	2,626	9	1,321	4	42
417	(922)	(7)	(372)	(3)	(276)	(2)	(13)
418	(132)	(2)	(54)	(0)	(39)	(0)	(3)
419	6,090	21	3,890	11	2,395	6	43
420	2,723	17	2,725	14	2,210	10	49
421	3,099	62	4,025	49	3,175	26	207
422	3,894	14	3,826	12	3,045	8	41
423	5,170	18	3,080	9	1,775	4	35
424	6,226	40	3,497	16	1,861	7	74
425	3,165	18	1,612	8	795	3	33
426	403	4	362	3	270	2	10
427	540	5	500	5	360	3	15
428	(851)	(10)	(364)	(5)	(156)	(2)	(17)
429	(245)	(5)	(108)	(2)	(48)	(1)	(9)
430	390	8	360	6	280	5	21

	1975-1983		1983-1990		1990-1995		1975-1995
TRACT	POPULATION INCREASE	PERCENTAGE INCREASE	POPULATION INCREASE	PERCENTAGE INCREASE	POPULATION INCREASE	PERCENTAGE INCREASE	TOTAL PERCENTAGE INCREASE
431	93	1	43	0	19	0	2
432	2,966	74	1,429	20	555	6	123
433	3,489	36	1,404	10	1,037	7	61
434	4,395	55	3,195	25	2,170	13	123
435	2,671	37	1,480	14	780	6	68
436	15,929	65	6,447	16	4,763	10	111
437	3,931	115	1,596	21	1,180	13	137
438	21,027	89	18,080	40	1,855	29	244
439	965	9	540	4	300	2	17
440	892	4	0	0	0	0	4
441	1,109	25	1,168	21	995	14	74
442	709	4	644	4	479	3	12
443	3,192	10	1,898	5	1,100	2	19
444	4,904	19	2,971	9	1,742	5	38
445	4,552	30	2,447	12	1,258	5	54
446	5,855	21	3,735	11	2,290	6	43
447	6,872	36	7,803	30	7,110	21	116
448	175	38	0	0	0	0	38
449	2,863	112	1,163	21	859	13	192
450	1,552	105	631	20	466	12	181
451	1,620	100	658	20	486	12	172
452	1,241	35	502	10	371	7	60
501	3	2	22	16	23	15	37
502	477	13	464	11	368	8	37
503	11	0	10	0	6	0	0
504	114	2	725	16	809	16	39
505	172	2	1,101	16	1,228	16	39
506	1,058	9	1,002	8	772	6	27
507	169	1	1,052	11	1,125	11	27
508	446	7	413	6	312	4	19
509	967	7	897	6	677	4	19
510	(187)	(2)	(159)	(2)	(111)	(1)	(6)
511	142	2	127	1	92	1	5
512	30	0	183	2	178	2	5
513	132	3	867	23	1,019	22	56
514	214	2	1,364	16	1,522	16	39
515	885	10	2,163	22	2,320	20	63
516	321	4	2,136	25	2,558	24	63
517	2,301	15	6,011	35	7,059	30	104
518	1,355	9	3,274	20	3,455	18	56
519	305	2	418	2	106	0	6
520	230	1	200	1	150	1	4
521	1,867	16	1,855	14	1,496	9	46
522	448	3	404	3	298	2	9
523	470	3	420	2	320	2	8
524	88	4	80	3	60	2	10
525	5,575	42	6,509	34	6,111	24	137
526	518	3	466	2	340	1	8
527	688	6	327	3	154	1	11
528	2,549	85	3,685	66	4,217	45	352
529	15,370	148	14,382	55	11,810	29	402
530	9,038	71	7,788	35	7,986	27	196
531	7,053	35	2,853	10	2,107	7	60
532	756	5	390	2	193	1	10
533	10,675	53	4,318	14	3,191	9	90
534	4,242	80	1,723	18	1,273	11	138
535	1,220	131	507	23	376	14	226
536	7,927	88	3,215	19	2,376	11	150
537	3,359	81	1,362	18	1,008	11	139
538	10,729	98	4,355	20	3,220	12	167
539	3,894	76	1,579	17	1,168	11	130
540	9,929	95	4,029	19	2,978	12	162
541	4,118	76	1,669	17	1,235	11	130
542	3,346	65	1,356	16	1,001	10	111

TRACT	1975-1983 POPULATION INCREASE	1975-1983 PERCENTAGE INCREASE	1983-1990 POPULATION INCREASE	1983-1990 PERCENTAGE INCREASE	1990-1995 POPULATION INCREASE	1990-1995 PERCENTAGE INCREASE	1975-1995 TOTAL PERCENTAGE INCREASE
543	274	38	112	11	83	7	66
544	64	75	26	17	19	10	128
545	7,146	67	2,894	16	2,139	10	114
546	314	47	127	13	95	8	81
547	183	30	130	16	55	6	51
548	128	27	51	8	39	6	47
549	314	47	128	13	94	8	82
550	449	55	182	14	134	9	94
551	5,098	92	2,069	19	1,529	12	157
552	1,035	50	419	13	310	8	85
553	657	19	265	6	196	4	33
554	216	35	88	10	64	6	59
555	4,040	94	1,641	19	1,212	12	161
556	2,933	69	1,189	16	878	10	118
557	323	44	131	12	97	8	75
558	6,856	82	2,781	18	2,055	11	140
559	12,758	349	3,148	19	2,327	11	499
601	2,601	33	2,381	23	1,813	14	87
602	8,083	72	7,435	38	5,666	21	190
603	1,648	46	1,511	29	1,151	17	121
701	8,798	36	9,709	29	7,731	18	108
703	1,209	17	1,335	16	1,063	11	51
704	35	4	39	4	31	3	12
705	73	6	80	7	64	5	20
706	115	5	124	5	99	4	16
801	146	28	197	30	218	25	111
802	597	17	810	19	892	18	66
803	333	4	440	6	483	6	18
901	6,558	53	5,441	28	5,207	21	140
902	12,748	87	10,719	39	10,265	27	232
903	4,331	47	3,537	26	3,382	19	123
904	103	7	83	5	78	5	19
905	432	20	351	14	336	12	54
1201	379	14	304	10	341	10	40
1202	399	9	317	6	357	7	24
1203	541	13	434	9	486	10	36
1204	274	8	219	6	245	6	22
1205	0	0	0	0	0	0	0
1206	13	0	8	0	9	0	1
1207	69	7	55	5	62	5	19
1208	293	17	235	11	265	11	47
1209	34	1	25	0	28	0	3
1210	21	1	16	1	19	1	4
1211	2	0	2	0	2	0	0
1212	1,126	16	905	11	1,016	11	45
1213	423	10	338	7	379	7	27
1214	146	6	115	4	129	4	16
1215	72	41	57	3	63	3	12
1216	230	8	184	6	207	6	23

COMMENTS

The following comments were received as part of the State's certification process and Environmental Protection Agency's pre-approval process. The comments are general in nature and/or pertain to items not included in the contracted Environmental Assessment scope of work approved by the State and E.P.A. However, as the comments are pertinent to management of the Greater Houston Area's water quality, they will be considered in future assessment work.

COMMENTS

1. On page II-C-12; it should be stated that local Soil and Water Conservation Districts administer or coordinate local programs in their district with technical assistance from the U. S. Soil Conservation Services.

2. On page I-8; regarding the recommendation that there be further study of "other potential harmful substantial data base exists on toxic materials in the water and sediment of the Houston area. The Houston Ship Channel has been intensively monitored for metals by TDWR. A significant amount of TDWR data also exists for synthetic organic chemicals in the Channel. A large amount of data exists for toxic contaminant concentrations in Channel Tributaries, by way of the USGS urban runoff monitoring program. Lesser amounts of TDWR and USGS data exist for contaminant levels in other area streams and bays. Any recommendations for further studies should be made in light of evaluating the data that presently exist.

3. On page II-D-1; regarding the statement that the prime source of water quality information in the Houston-Galveston area is the H-GAC Data Base, it does not contain a considerable amount of data that is in the TDWR Statewide Monitoring Network data system. The SMN system extends back in time three more years (through Water Year 1968), and includes a number of parameters (e.g. metals and synthetic organic chemicals in water sediment, and fish/shellfish tissue) apparently not contained in the H-GAC Data Base. These data are available upon request.

4. On pages II-D-4 through II-D-22; the information given in Tables II-D-2 through II-D-17 is not sufficient to allow a determination of whether the Water Quality Standards have been correctly applied. For instance, were fecal coliform levels compared to the limit on geometric mean or the limit on variations? Information on the tables should be sufficient to allow the reader to determine for himself whether standards were violated. There should also be an identification of the agency or agencies who contributed the data that are tabulated.

Finally, the text summarizing data for Segments 1006 and 1007 should be revised to reflect improvements in bacterial quality that have followed recent improvements at the Northside STP. During Water Year 1977 these segments were essentially in compliance with fecal coliform standards.

5. On page II-D-20; the water bodies listed as having no baseline information available, all have been monitored by the TDWR. This information is available in the Statewide Monitoring Network data system.

6. On page II-F-1; the fecal coliform standards for some Texas streams are incorrectly labelled MPN/100 ml. "MPN" specifies a specific bacteriological test, whereas the bacteriological standards are only defined in terms of number/100 ml. Acceptable test procedures include the MPN test, Millipore filter test, or any other test approved in Standard Methods.

7. On page II-F-3; there should be some development of the basis for the statement that bacterial levels in the Houston Ship Channel constitute the most serious public health problems in the area. Considering present patterns of water usage, high bacterial values in streams used for recreation would appear to be a more serious public health problem. Considering the levels and persistence of certain synthetic organic chemicals in the Ship Channel, these would also appear to constitute a more serious public health problem.

8. On page II-G-16; the EPA criteria for dredged spoil are designed to restrict the method and location of disposal for contaminated spoil. They do not, as stated in the report, restrict which sediments should and should not be dredged.

9. General; population figures utilized for Spring Creek and Cypress Creek Sub-basins are inconsistent with estimates based on recent studies by the TDWR District 7 office. Results of the TDWR study are available from the District Office for consideration during the continuing planning process.

10. On page IV-1; the responsibilities recommended to be assigned to a Water Quality Council are vaguely broad, and appear to overlap with the present responsibilities of the TDWR. There should be a more specific statement of the responsibilities of the Council, and clarification of the apparent overlap or it should be mentioned that TDWR will continue performing the functions of management/coordination until the Water Quality Council is established.

11. On pages IV-1 through IV-3; recommendations for additional data collection, analysis, model verification, et. al. should be accompanied by identification of the agency responsible for

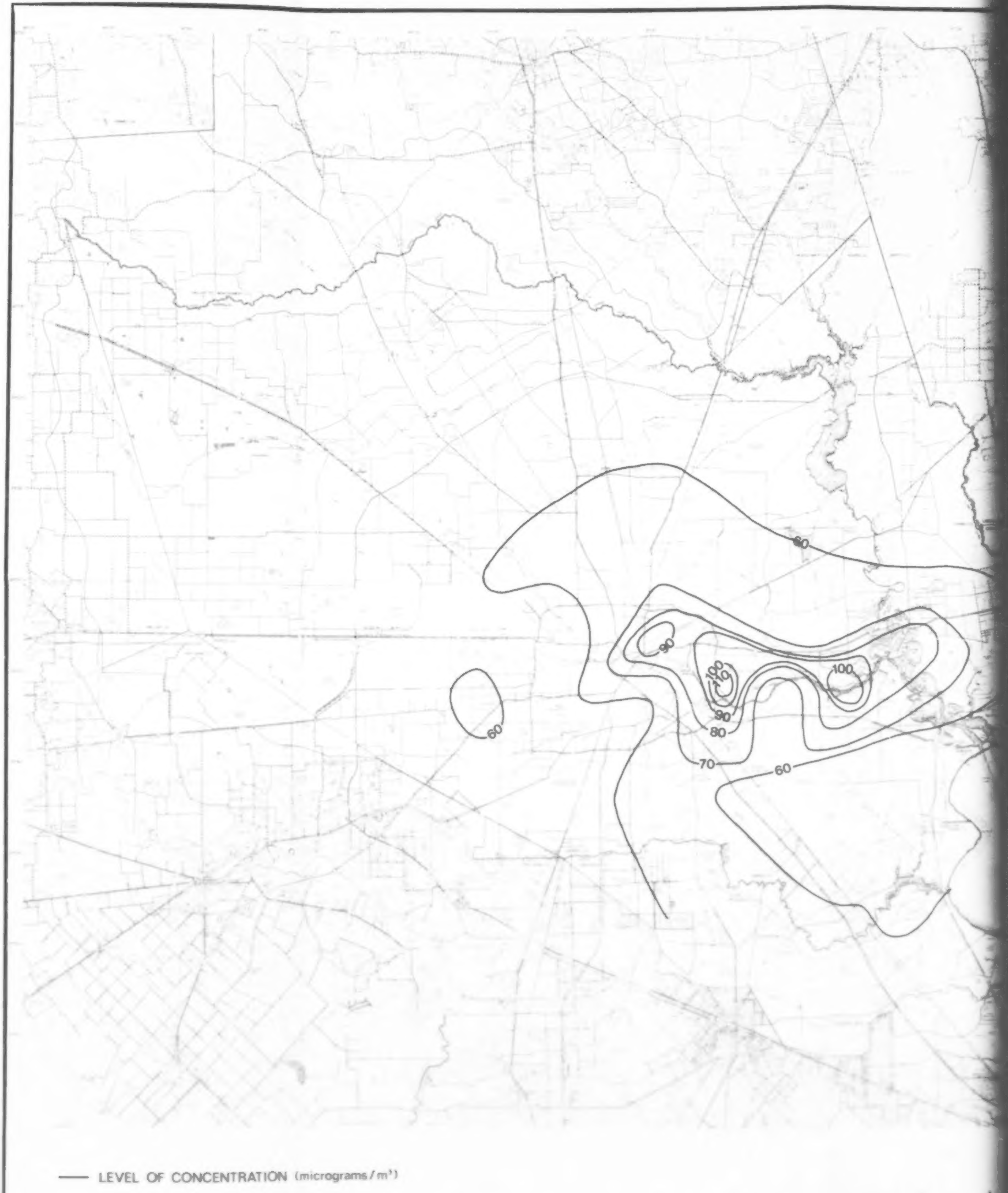
each. If the responsible agency is identified elsewhere in the 208 outputs, then reference should be made to that document.

12. On page V-D-5; Houston Ship Channel Segments 1007 and 1006 are shown as having a fishable, swimmable water quality achieved by 1995. Such a characterization would appear to conflict, not only with a realistic assessment of the Channel's potential uses, but with other statements in this and other 208 reports for the Houston area. These latter include statements that the Channel does not meet its water quality standards at present under dry weather conditions, and that it is unlikely to meet the present standards under wet weather conditions in the future. The upper Channel could never be safely utilized for swimming or boating, anyway, due to the heavy volume of large ship traffic.

13. On page V-D-6; the statement that all remaining unclassified bayous are projected to have fecal coliform levels below 200, should be re-examined. TDWR data show present levels to be far in excess of 200 at numerous points, and the plan calls for maintaining present permit standards.

14. The procedures to be followed if archeological resources are found during construction should be included in Chapter II-1.

15. Archeology should be discussed in Chapters V and VI.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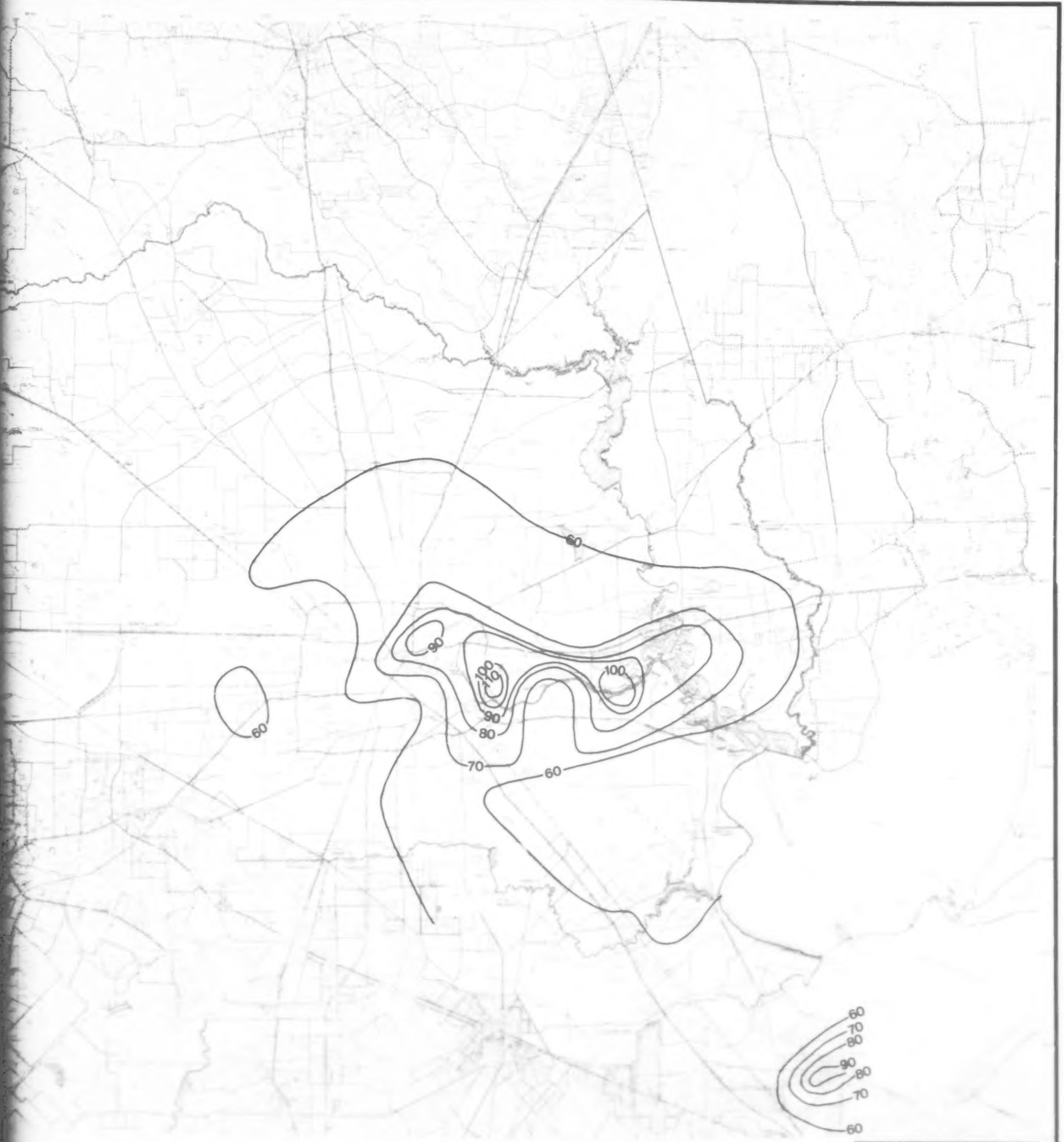
— LEVEL OF CONCENTRATION (micrograms/m³)

Areawide Waste Treatment Management Plan
HOUSTON AREA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Areawide Waste Treatment Management Plan
HOUSTON AREA

N
SCALE

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

PARTICULATES - ANNUAL
GEOMETRIC MEAN (1976)

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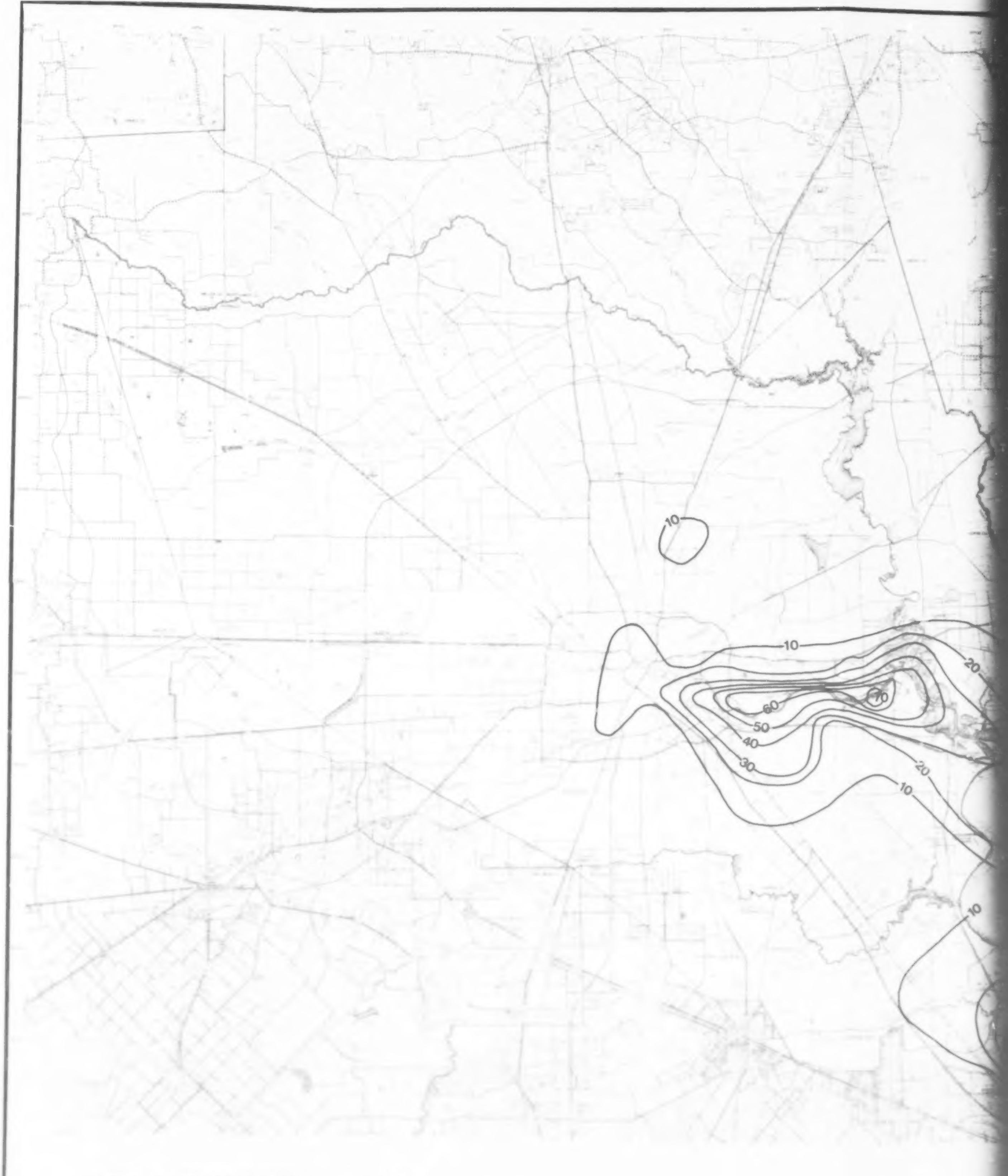
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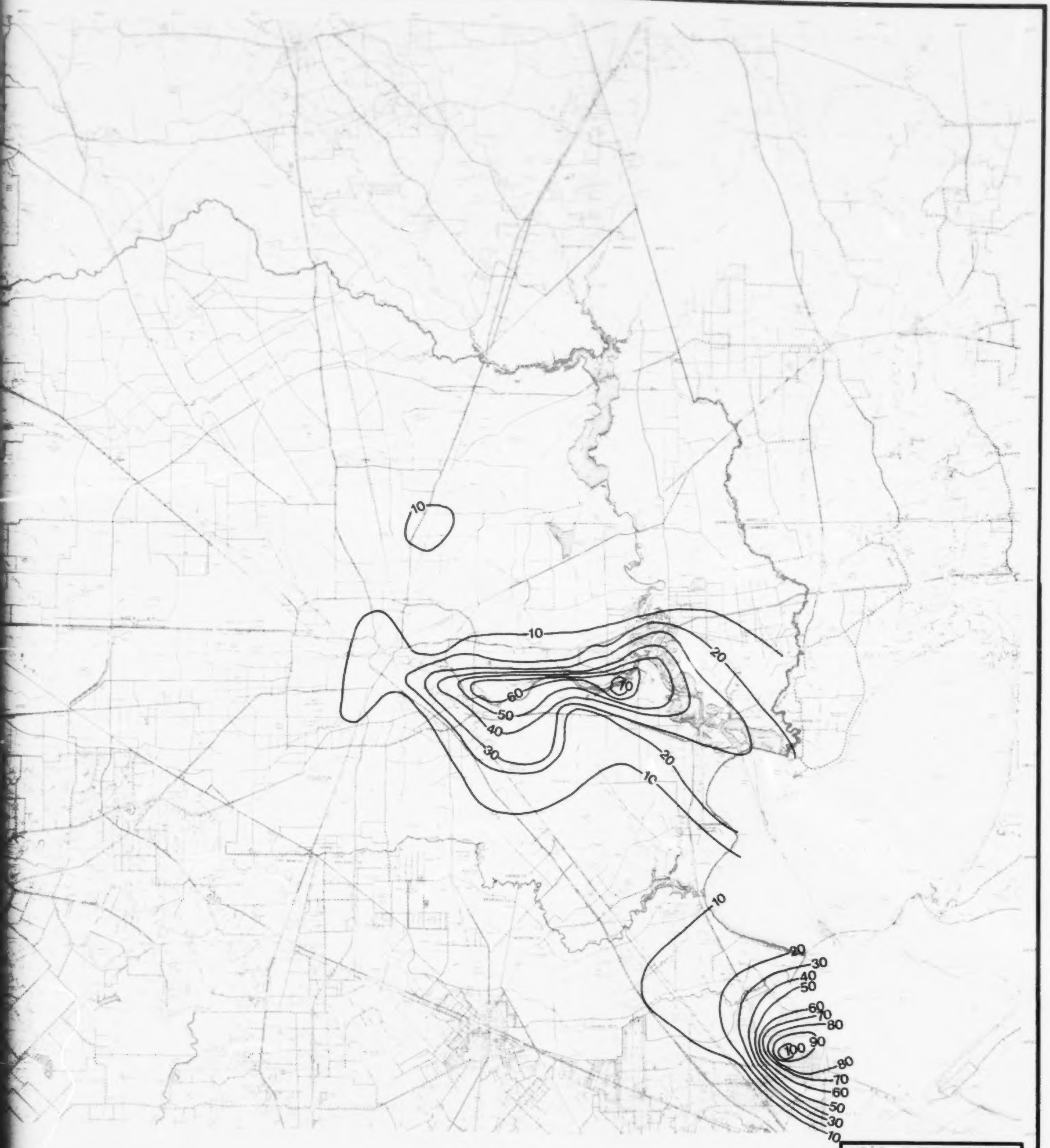
— LEVEL OF CONCENTRATION (micrograms/m³)

Areawide Waste Treatment Management Plan
HOUSTON AREA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ION (micrograms / m^3)

Areawide Waste Treatment Management Plan
HOUSTON AREA

N
SCALE

HGAC GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

SULFUR DIOXIDE, SECOND HIGHEST
24-HOUR AVERAGE (1976)

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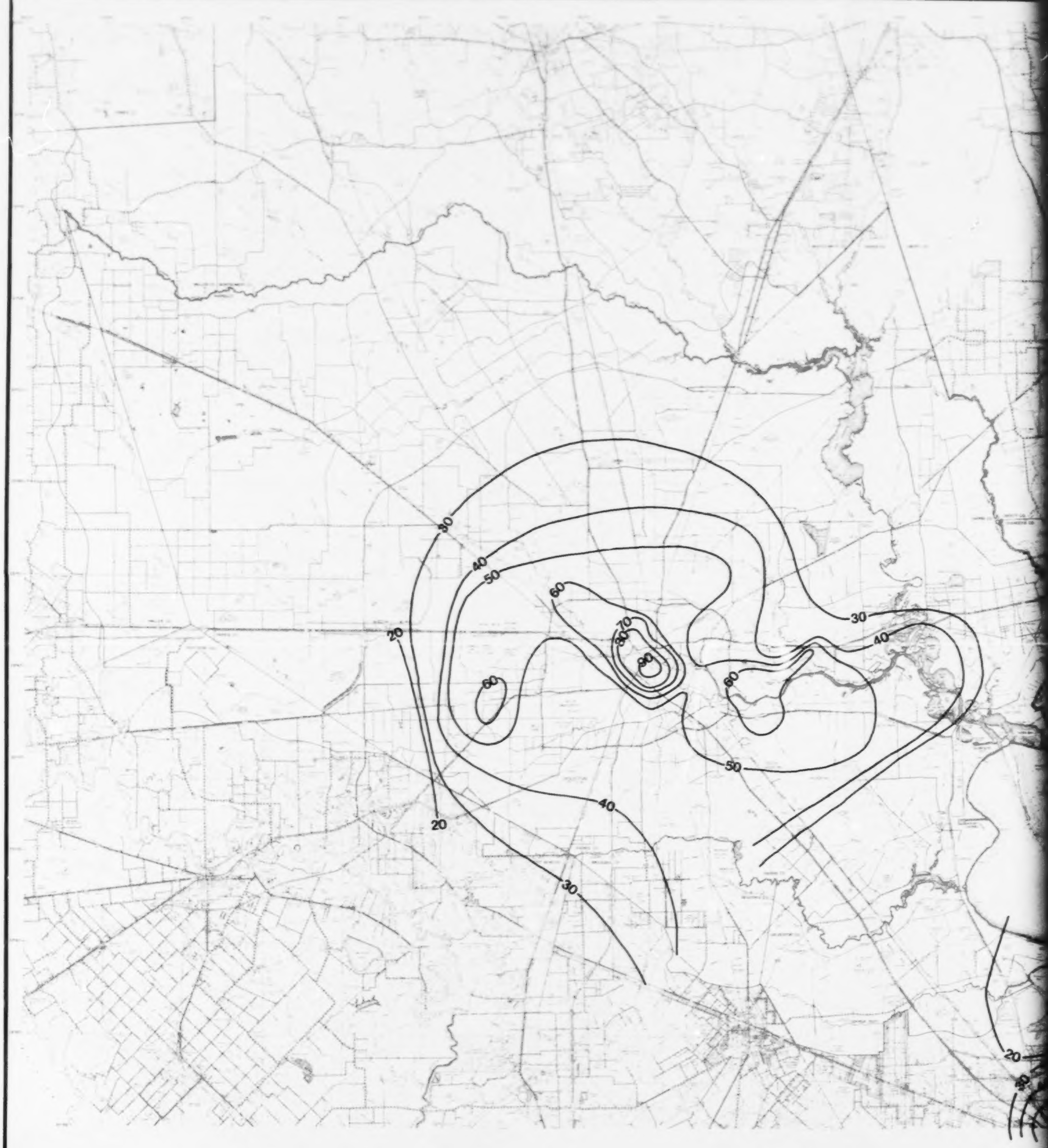
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—— LEVEL OF CONCENTRATION (micrograms/m³)

Areawide Waste Treatment Management Plan
HOUSTON AREA

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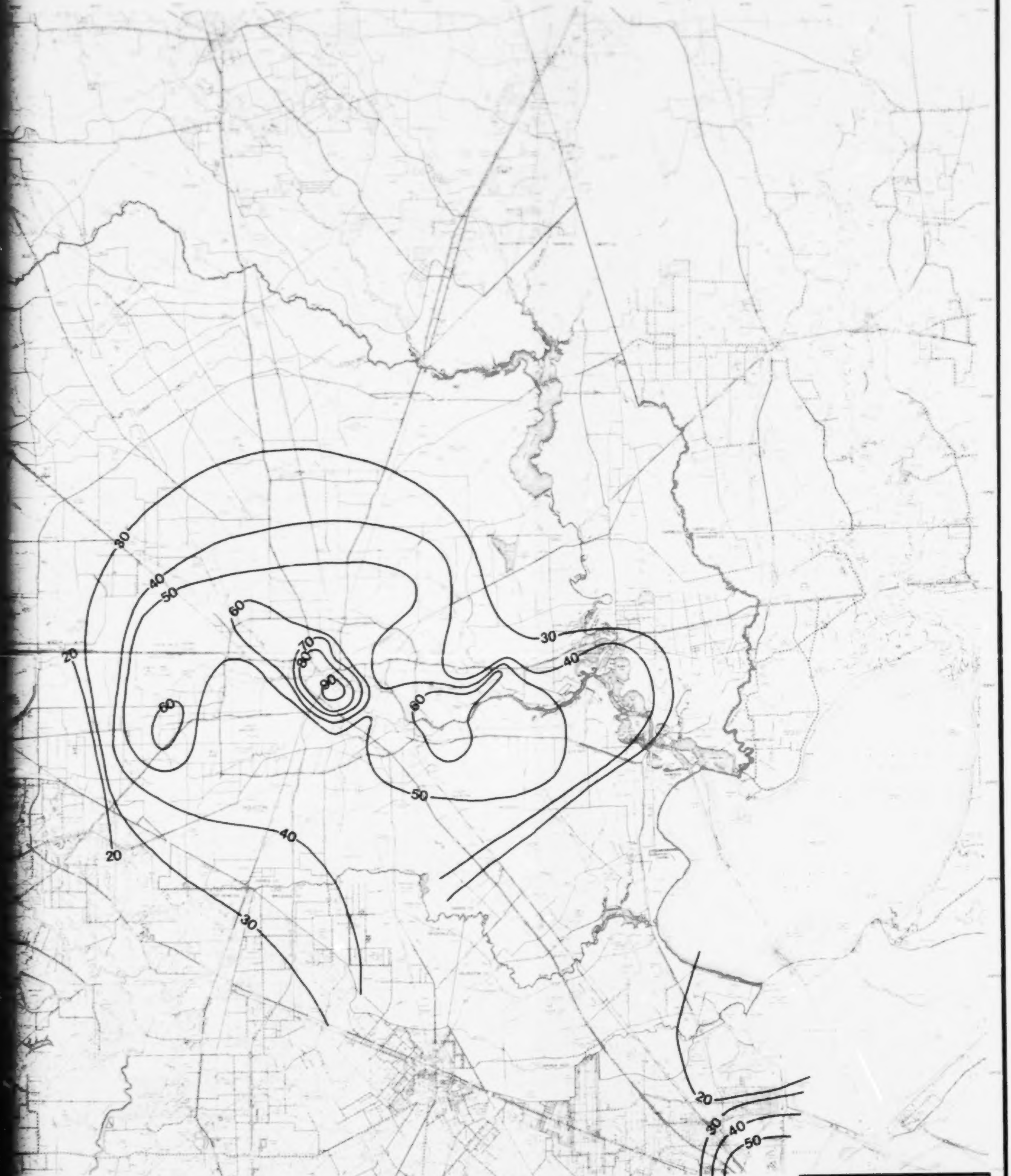
SCALE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GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

NITROGEN DIOXIDE
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grams/m³)

Areawide Waste Treatment Management Plan
HOUSTON AREA

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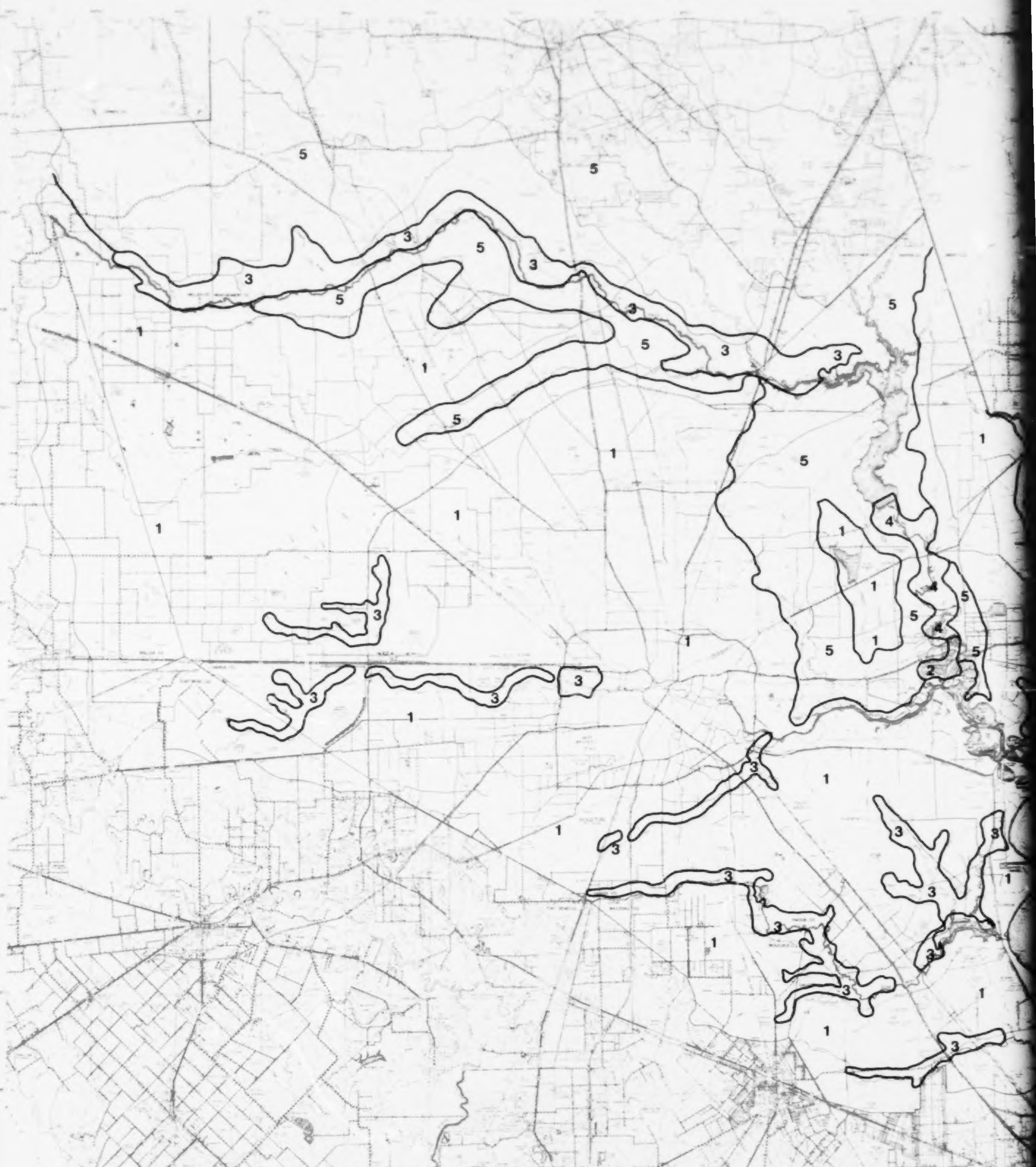

1 COASTAL PRAIRIES
2 COASTAL MARSHES
3 HARDWOOD GALLEY FORESTS
4 HARDWOOD SWAMPLANDS
5 OAK-PINE UPLAND FORESTS

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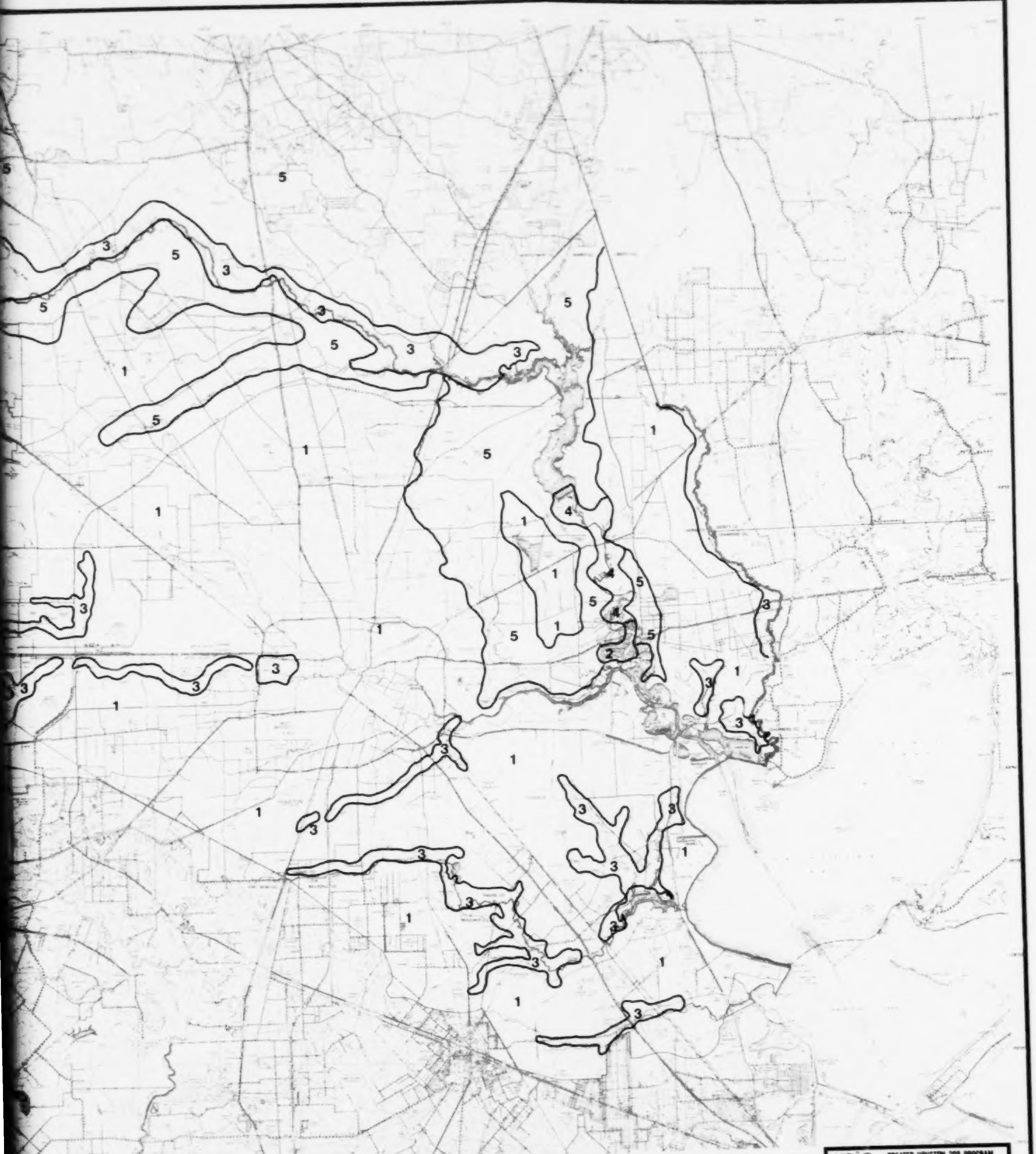
HOUSTON AREA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Areawide Waste Treatment Management Plan
HOUSTON AREA

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GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

POTENTIAL VEGETATION OF THE
208 STUDY AREA

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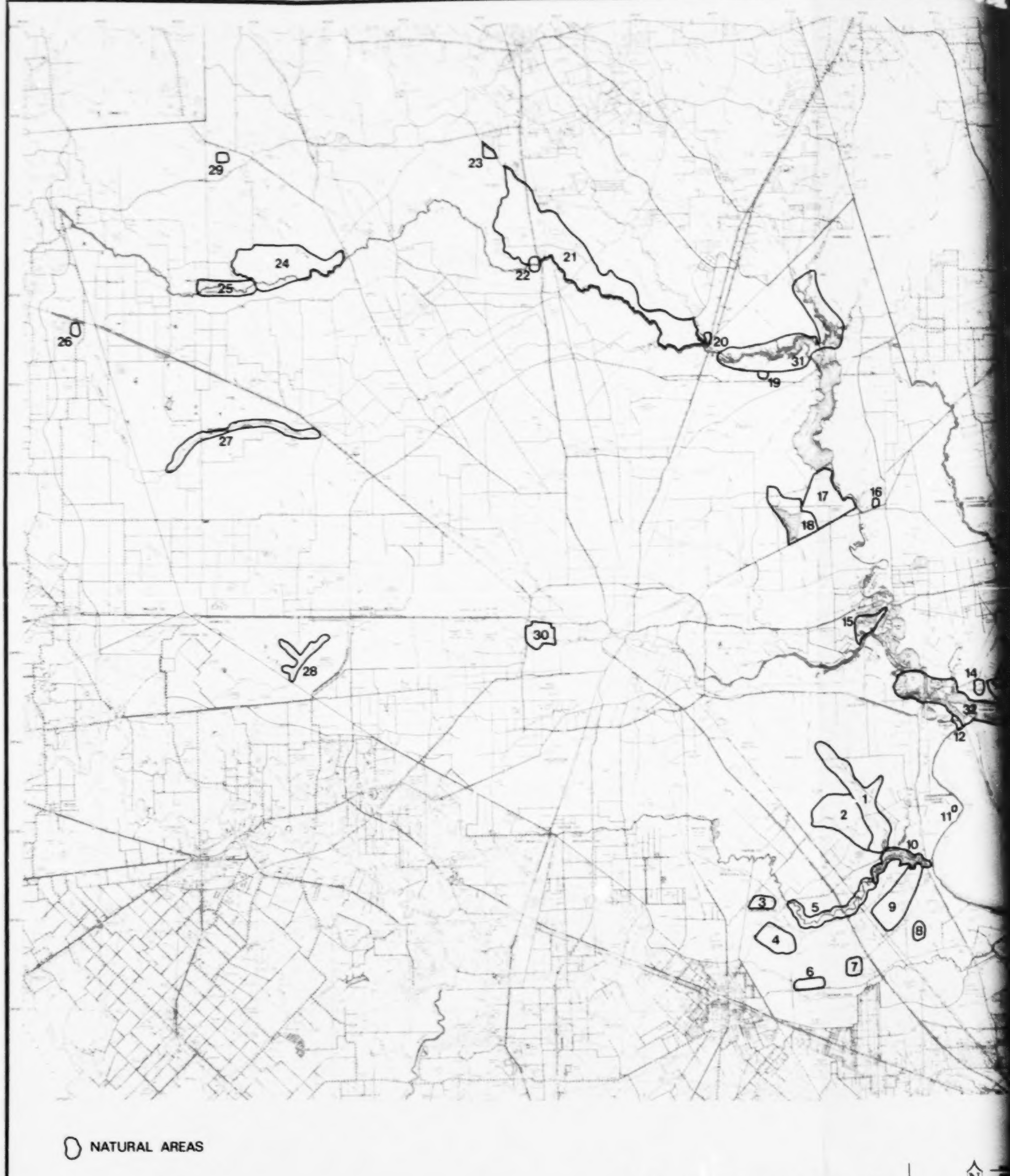
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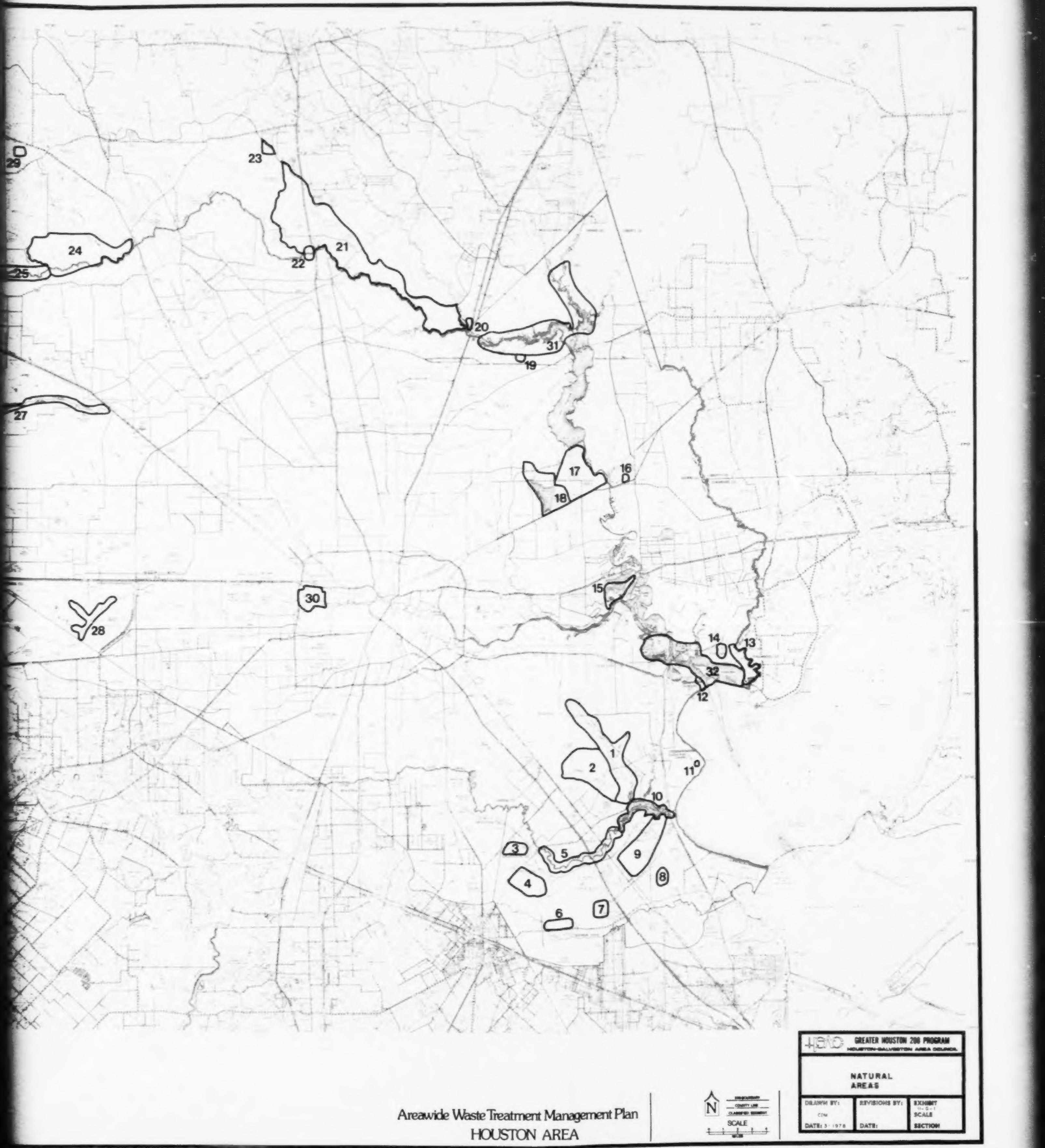
▢ NATURAL AREAS

Areawide Waste Treatment Management Plan
HOUSTON AREA



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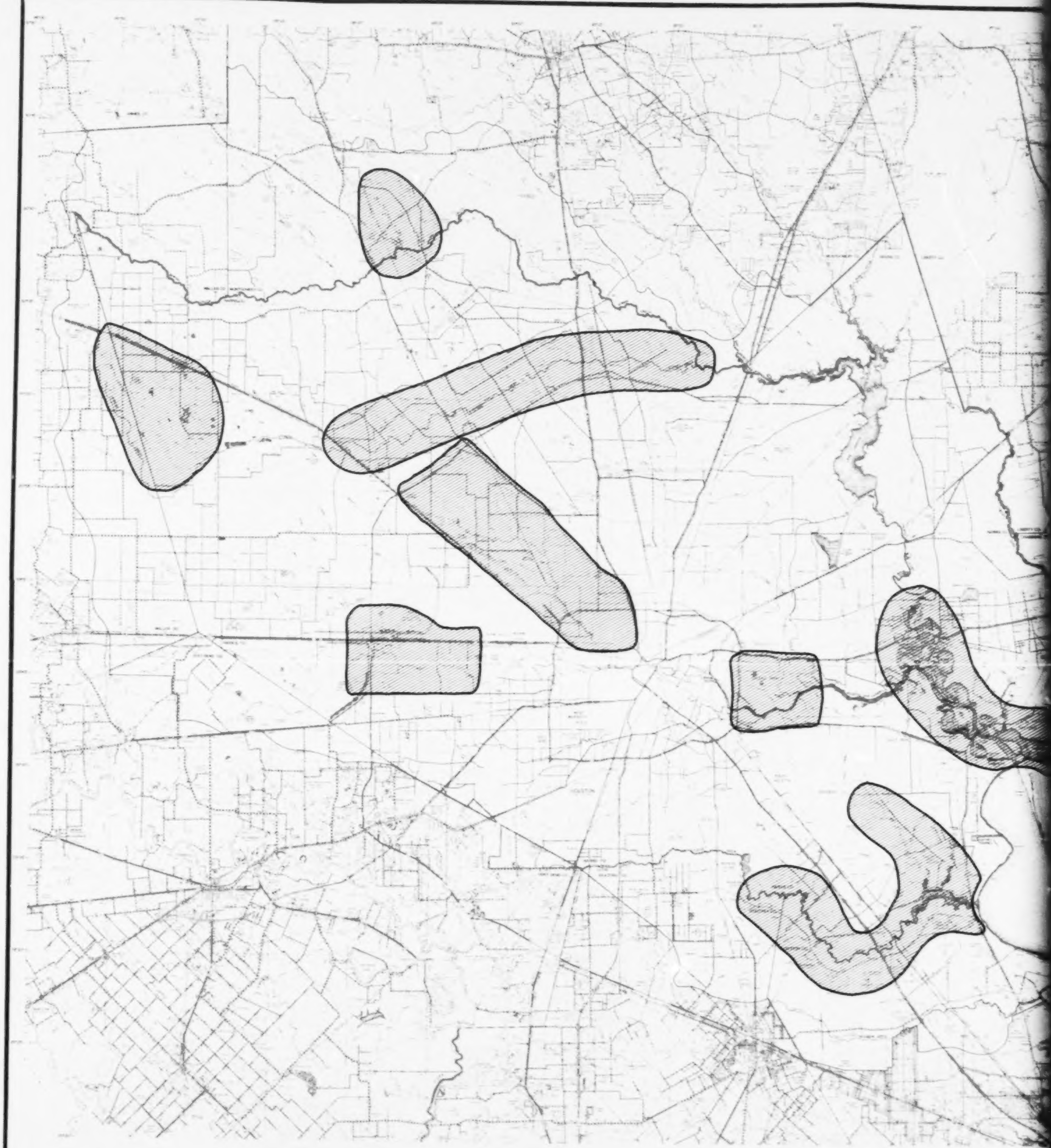
Areawide Waste Treatment Management Plan
HOUSTON AREA

GREATER HOUSTON 208 PROGRAM
HOUSTON-GALVESTON AREA COUNCIL

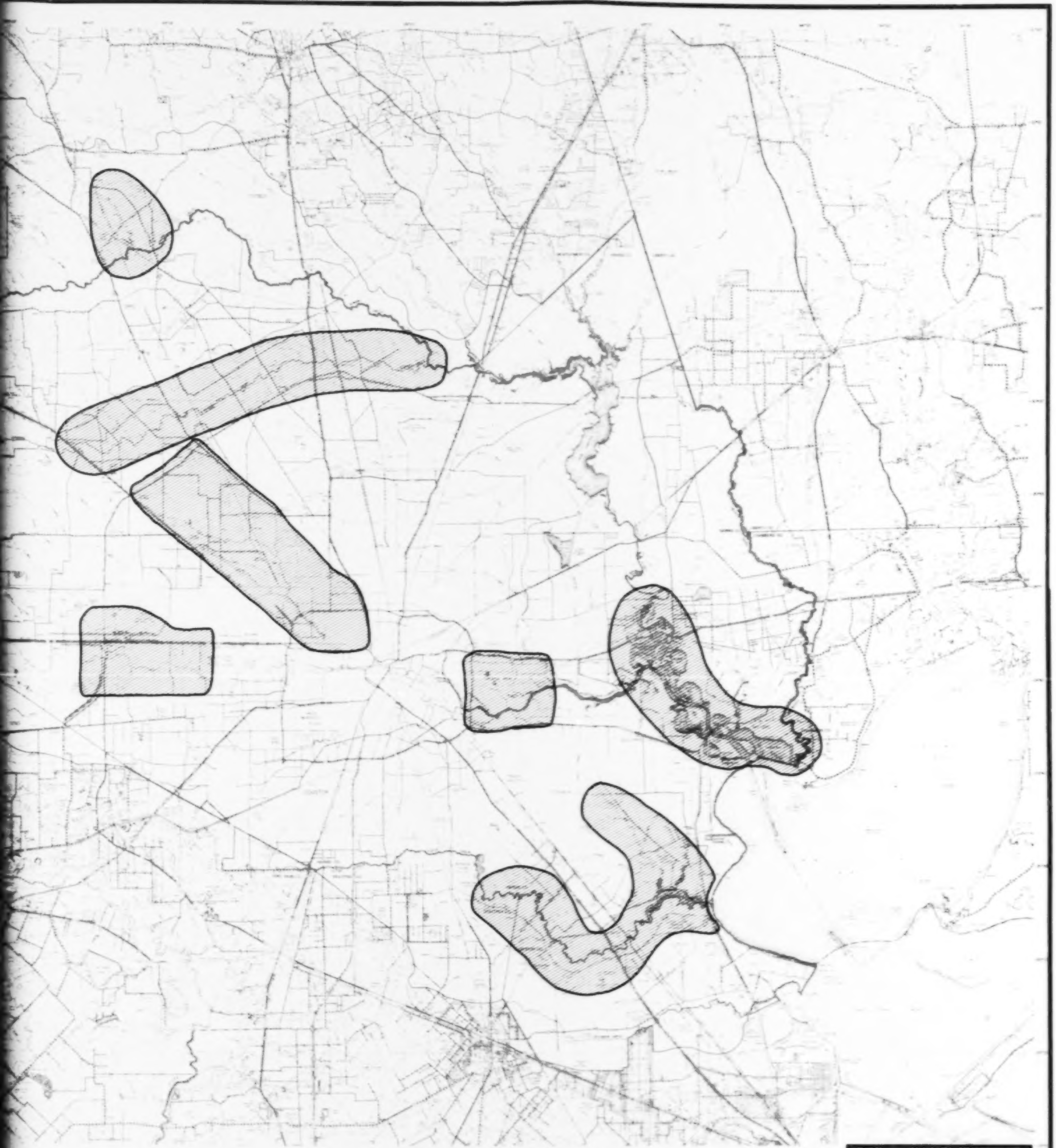
NATURAL
AREAS

DRAWN BY: CDM DATE: 3-1978	REVISIONS BY: DATE:	EXHIBIT II-G-1 SCALE SECTION



▨ ARCHEOLOGICALLY SENSITIVE AREAS

Areawide Waste Treatment Management Plan
HOUSTON AREA



SENSITIVE AREAS

Areawide Waste Treatment Management Plan
HOUSTON AREA

SCALE

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HOUSTON-GALVESTON AREA COUNCIL

ARCHEOLOGY

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